TECHNOLOGY DEPT.

# Power Generation and POWER PLANT ENGINEERING

For ALL Power Engineers • Steam, Electricity and All Other Power Engineering Services

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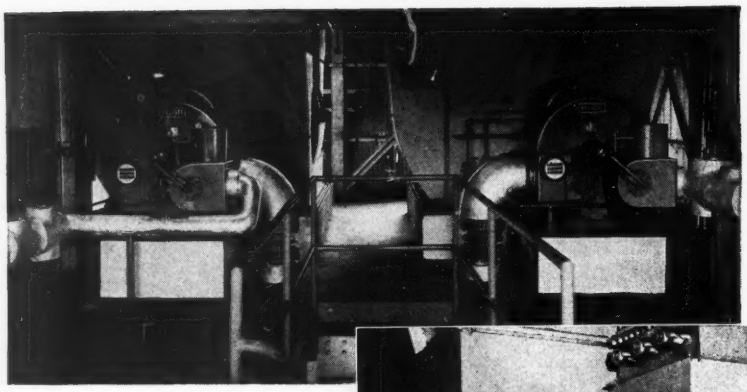
## COMPLETE CONTENTS

★ Huey Station Gas Turbine Opens New Chapter in Power Generation .... 54
Hickling Station .... 57
★ Let the Flexibility Prism Help You Analyze Pipe Stress .... 58
*By Charles H. Green*
Chart Simplifies Fuel Purchasing .... 63
*By Tyler G. Hicks*
★ Power Supply Affects Choice of Mine Hoist Drive .... 64
*By E. A. Rich*
Telephone Influence Factor and What to Do About It .... 68
*By G. L. Oscarson*
Power Generation News Reel .... 72
Brazing .... 74
Basic Power Plant Figuring .... 74
*By William H. Engelman*
Ventilation at O. H. Hutchings Station .... 76
*By C. Russell Dole*
★ New Versenate Test for Total Water Hardness Eliminates False End Points .... 79
*By F. R. McCrumb*
Shorts .... 83
Atomics Digest .... 84
Where Would You Put 300 Tons of Fly Ash Every Day? .... 85
Refractory Enclosures Behind Waterwalls .... 86
*By George P. Reintjes*
Central Heating Pays—Why Don't We Have More of It? .... 88
*By A. E. Richards*
Metallizing Repairs on Hydroelectric Equipment .... 92
*By John E. Wakefield*
Electric Shock—Can Be Either Injury or Treatment .... 96
*By Dr. W. Schweisheimer*
Blueprint Protection .... 98
*By Thomas Trail*
Yearly Index .... 125

## Regular Departments

Notes on This Issue .... 5
Engineers' Preview .... 7
Helpful Bulletins .... 35
New Equipment News .... 42
Letters to the Editors .... 53
Common Sense Isn't As Common as It Should Be
Thoughts on a Practical Thermoelectric Generator
Questions and Answers .... 80
Should He Use Accumulator on lines to Steam Presses?
How Do You Test a Ladder?
Who Can Help This Engineer Pump Cold Molasses?
Can They Use Molasses As A Fuel?
Why Is This Circuit Grounded Through A Fuse?
Why Did Motor Rotor Operate Off Center?
What Makes Turbine No. 2 Drop Load and Lose Vacuum?
Construction News .... 100
Coming Events .... 102
New Engineering Books .... 104
Catalog Library .... 112

DECEMBER
1949



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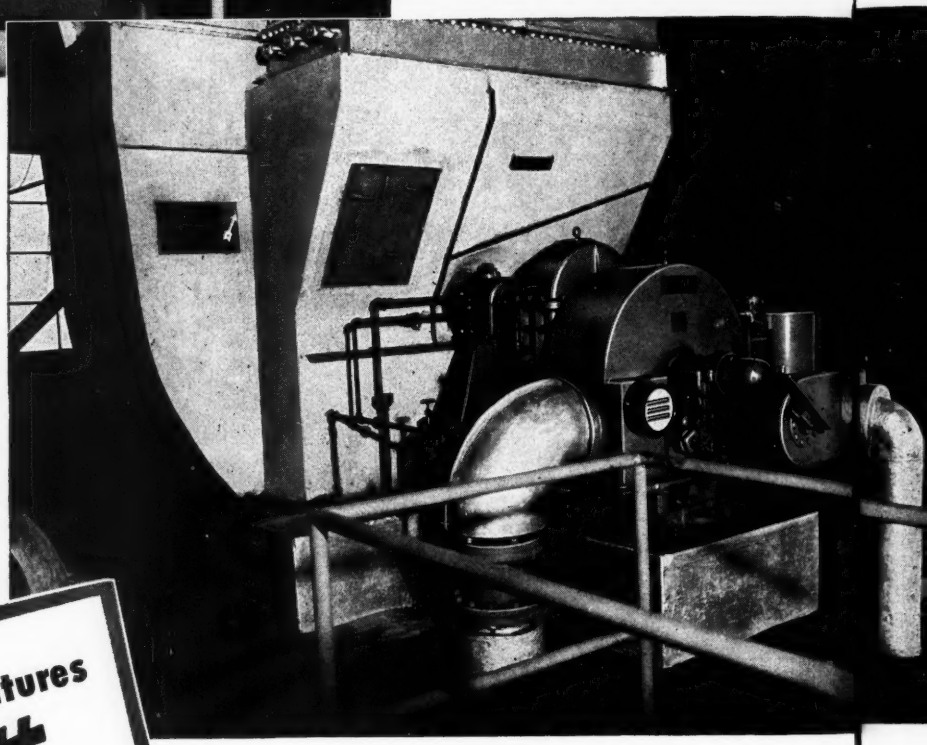

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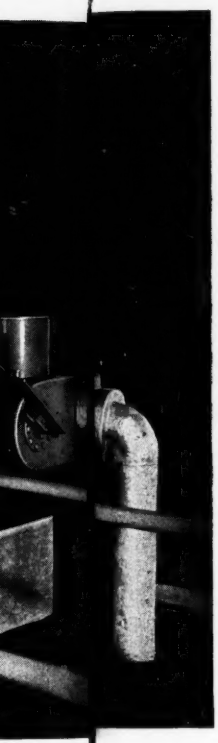

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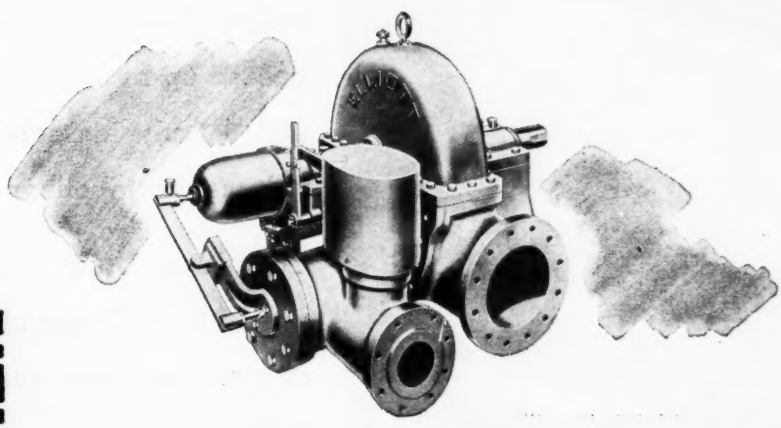
In the installation shown here, two standard YR turbines are fitted with built-in gears to make a compact, neat, and workmanlike installation. They are driving induced draft fans in a new boiler plant of a large chemical manufacturing plant.

Along with their exceptional adaptability Elliott YR turbines maintain the tradition of Elliott simplicity and dependability. As one plant engineer said recently to another engineer who had beer. having drive troubles, "Why don't you put in Elliott turbines and stop worrying?"



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# Power Generation

## December 1949

VOLUME 53—NUMBER 12

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## Notes on This Issue

### Huey Station Gas Turbine

The gas turbine power plant has really arrived as the fourth class of prime mover in the stationary power field. The first important installation is the 3500-kw unit driving a generator at the Arthur S. Huey station of Oklahoma Gas & Electric Co., Oklahoma City. It went into service in July 1949 and to date has operated continuously and satisfactorily.

This unit burns natural gas and is extremely compact and simple. Its successful operation culminates a long period of pioneering and experimentation about which you have been kept posted in these pages.

The Huey Station is the first of four installations for stationary power generation. The others are rapidly coming to completion; one for Public Service Co. of Oklahoma, another for Bangor Hydro-Electric Co. of Bangor, Me., and the third for Central Maine Power Co. at Farmingdale, Me.

Be sure to note the interesting feature regarding the utilization of exhaust gas to heat feedwater.

### New Test for Water Hardness

The familiar soap test for total hardness of water has been used in many boiler rooms for years. This test is time consuming and sometimes inaccurate, because of the misleading false end point.

Now we have a new test giving a positive indication by a definite color change in the sample, like the familiar alkalinity test. Thus there is no question of a false end point. No special equipment is needed—just the same flasks, burette and other items used in other standard water tests. All you need in addition are the new chemical reagent, indicator and buffer solutions, all readily available.

The method was developed at the University of Zurich and has been further investigated at Iowa State College.

This article describes the test in nonchemical language and illustrates the four simple steps required in making it.

As this issue goes to press some further refinements and improvements in this Versenate test have been submitted which will be taken up in subsequent issues.

### Power Supply Affects Choice of Mine Hoist Drive

In this article Mr. E. A. E. Rich analyzes the performance of large motor drives. The application here is to mine hoist drives but the information is just as good for other large motor drives.

The drive involves not only the motor but the entire control equipment as well and in selecting such drives it is necessary to consider not only the requirements of the driven machinery but also the characteristics of the power system to which the drive is connected.

Mr. Rich not only explains the problems but shows how to attack them as they arise and uses a number of interesting graphs.

### Chart Simplifies Fuel Purchasing

This chart should be of value to all engineers in the selection of the proper fuel for most efficient generation of power.

It is an alinement chart which takes into consideration, the heating value of the fuel, the efficiency of combustion, the price of the fuel and its cost per million Btu.

With this chart any operator can, with little effort, determine which fuel is best for his plant.

### Telephone Interference from Power Circuits

When power circuits set up interference in telephone circuits the power engineer is on the spot.

Generators and motors set up harmonic currents which can raise hob with telephone circuits. This article tells the power plant operator how to reduce the effect of these harmonic currents by the installation of properly designed filter circuits.

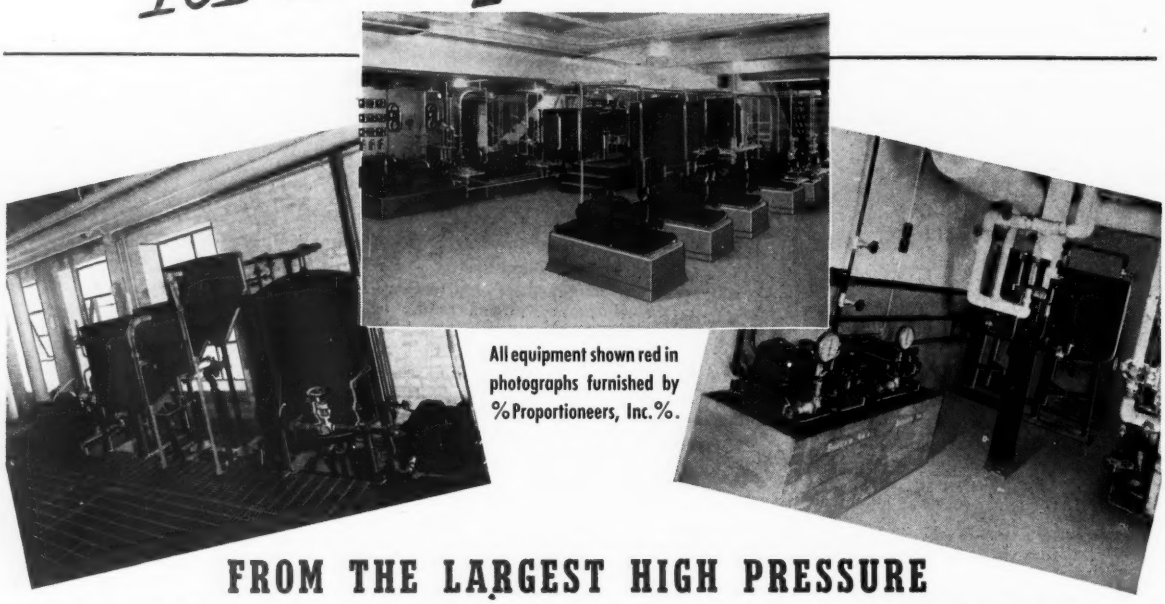
### Flexibility Prism to Analyze Pipe Stress

Many readers are interested in calculation of high-pressure, high temperature piping. This article gives a new concept in 3-dimensional pipe stress analysis.

The author proposes that the flexibility prism be used as a criterion to aid in the solution, claiming it will accomplish in 30 minutes what would otherwise require 24 hours.

## CHEMICAL TREATMENT METERING PUMPS

# *for Every Power Plant*



All equipment shown red in photographs furnished by %Proportioneers, Inc.%.

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# ENGINEERS' PREVIEW

**CONTRARY to general belief, outdoor air is not purified by a hard rain. On the contrary, mold spores, which originate in decaying animal and vegetable matter, are just as prevalent in the air after a rain as in dry weather, according to A. H. Taylor, physicist in General Electric's Lighting Research Laboratory Studies indicate that it should be possible to reduce economic losses due to mold contamination, especially during the manufacturing processes, by practical installations of germicidal lamps, according to the G-E physicist. He pointed out that spores may be killled either while they are in the air or after they have settled on the surface of products.**

**Air-borne disease germs expelled by persons with infectious respiratory diseases can be destroyed by direct exposure to germicidal ultraviolet energy in a very few minutes, thus making and keeping the air of an occupied room much safer for occupants to breathe, according to Taylor.**

★ ★ ★

OVER 85 PER CENT of the lighting in the average American city is inadequate. This fact developed from a survey of Indianapolis, Indiana, just completed for the Industrial and Commercial Lighting Equipment Section of the National Electrical Manufacturers Association by an independent market research agency. A year's promotional program of relighting under the direction of the Electric League of Indianapolis Inc., was scheduled to start on October 1.

Analysis of national data revealed that Indianapolis lighting fixture sales were very close to national average, being better by about 13 per cent .

Measurements with footcandle meters indicated that at least 85 per cent of the lighting in this average American city is inadequate by Illuminating Engineering Society standards. In a group of areas, all of which are recommended for 50 footcandles of illumination by IES. standards, readings of 46 footcandles and better accounted for only 9 per cent of the total. In these same types of areas over one-third were less than 10 footcandles, and considerably over one-half were less than 20 footcandles.

These data indicate that the market for lighting is not even approaching saturation. The Indianapolis study shows that the public expects to buy during the next twelve months approximately 24 per cent more lighting fixtures than have been purchased in an average postwar year.

★ ★ ★

**PROGRESS of one of the largest man-made fires in history, burning underground 55 miles northwest of Birmingham, Ala., is being followed by means of a G-E electronic mecury-vapor detector.**

**The fire is in the Alabama Power Co.'s Gorgas Mine, where experiments in producing gas by igniting a coal vein underground are being conducted by the U. S. Bureau of Mines and the Southern Research Institute. At regular intervals through the vein, small capsules of mercury have been placed in the path of the blaze. When the fire, which may create temperatures as high as 3000 F, reaches a capsule, the mercury is vaporized, and the instrument detects the fact. The detector is not affected by carbon monoxide and hydrocarbons produced by the subterranean fire.**

NEW USES for aluminum are developing daily and more and more electrical energy will be required to produce it, Donald M. White, of New York, Secretary of the Aluminum Association, told an AIEE meeting recently. The industry produces about 1,250,000,000 lb of pure aluminum yearly, requiring the use of 12,500,000,000 kwhr of electricity. Aluminum has more than 4,000 uses and is a basic raw material for more than 17,000 businesses in the United States, employing approximately 1,000,000 persons. In 1852, pure aluminum cost $545 a pound, but largely due to the use of cheap electricity, the cost is now between 15¢ and 17¢ a pound and production has risen from 50 lb in 1888 to 3,500,000 lb daily today.

"History and growth of the aluminum industry have closely paralleled those of the electrical industry," Mr. White told the electrical engineers. "In fact . . . the great technological achievements of the electrical industry have played a significant role in the progress of the aluminum industry. Electrical progress has brought cheaper electric power; cheaper power has meant cheaper aluminum; and cheaper aluminum has led to new uses and mounting demand for the metal."

Electric energy is an essential ingredient of aluminum, and represents some 20 per cent of its total cost.

★ ★ ★

**DR. FRANK B. JEWETT, of Short Hills, N. J., former president of the National Academy of Sciences, and an outstanding figure in the scientific and engineering world, will be awarded the Hoover Medal for 1949, one of the highest honors of the engineering profession. The medal is awarded by the ASCE, ASME, AIME and AIEE, and will be conferred on Dr. Jewett at the Winter General Meeting of the latter society, January 30-February 3, 1950 in New York.**

**The medal, first awarded Herbert Hoover in 1930 and named for him, is given "by engineers to a fellow engineer for distinguished public service."**

**For many years Dr. Jewett was vice president of the American Telephone and Telegraph Company, and president of the Bell Telephone Laboratories. He is a former president of the AIEE.**

★ ★ ★

SIX REQUIREMENTS for a dynamic technological economy with a rising standard of living were outlined recently by William J. Kelly, president of the Machinery & Allied Products Institute. Attainment of a highly developed dynamic technological civilization has been a rare occurrence in human history, Mr. Kelly said. Preservation once attained, has been equally difficult, but today the maintenance of such an economy for the United States and the Western European democracies is a matter of life and death.

The basic requirements for such an economy, according to Mr. Kelly, are:

1. A high level of education.
2. A wide diffusion of initiative.
3. A strong system of incentives.
4. An adequate supply of capital.
5. An extensive development of scientific and technical research.
6. A prompt application of technological advances.

**METALLURGY is the highest paid of the engineering professions, according to a recent National survey by the American Society for Metals. The average income for metallurgists, according to the ASM analysis, is $6,567. The National average income for all types of engineering, according to the U. S. Bureau of Labor Statistics, is $4,6[illegible]8. Comparisons with other professional incomes are equally impressive. The lawyer receives an average of $5,719; the chemical engineer's annual average is $4,320. The average yearly income of all college graduates in the U. S. is $4,689, while the average yearly pay of all U. S. workers is $2,840.**

**Three factors were shown to affect a metallurgist's income—his responsibility, his college or technical training, and the length of time on the job.**

★ ★ ★

PLANS for publishing a directory of the names and products of American small business firms for the attention of overseas buyers have been completed by the Economic Cooperation Administration.

In the first government project of its kind, the ECA will list the names and products of small independent firms desiring to enter or continue in export trade under the Marshall Plan. The directory will be distributed by ECA overseas missions to European importers and other buyers, and will serve as a ready reference to available American sources of supply.

The directory will be printed in the languages of the countries participating in the recovery program and will be paid for out of European counterpart funds. Listing in the directory will be without charge to American small business enterprises.

★ ★ ★

TUBING THAT will withstand the unusual pressure of 10,300 psi at 1000 F, is included in the piping system produced by the Babcock & Wilcox Tube Co. for the coal-to-oil demonstration plants recently opened by U. S. Bureau of Mines at Louisiana, Mo.

★ ★ ★

SUPERSENSITIVE instrument designed to measure minute changes in the blood's oxygen content or the cooling rate of steel during quenching was recently described by Joseph F. Lash of General Motors Research Laboratories. This is the contact modulated amplifier developed by GM Research during the war and since used in hospital and industrial laboratories. New applications of it remain to be explored. It is virtually like a portable radio and operates almost anywhere with undisturbed stability.

In medical use, for example, the instrument records directly the per cent of oxygen saturation of the hemoglobin of the blood stream. Light from a small lamp is directed through a thin section of flesh and the external part of the ear and falls on two photocells in opposition. A red filter is in front of one cell and a green filter in front of the other. The cell behind the green filter responds to changes in tissue thickness and changes in total volume of blood, while the cell behind the red filter responds to these volume variables, as they are called, as well as to changes in oxygen saturation of the blood. Thus the difference signal developed and applied to the amplifier is proportional to the blood oxygen saturation. Such information is extremely valuable to anesthestists and surgeons during operations. In another field, the quenching or hardening of steel, the amplifier is linked with thermocouples attached to a test bar of steel. It records the cooling rate which is always extremely fast in the initial moment of the quench and aids metallurgists in classifying steels.

NEW CAST IRON which, unlike ordinary cast iron, is not brittle but can be bent or twisted, can now be made readily and economically and used in a myriad of applications. It is probably the most outstanding metallurgical develapment in the foundry industry since around 1820 when Seth Boyden first made, from cast iron, the American type of malleable iron at Newark, N. J. The novel product, popularly known as ductile cast iron, has several times greater strength than ordinary cast iron with greatly increased ductility and shock-resistance. These facts were presented by Don Reese, well-known foundry expert and engineer, before the annual meeting of the Gray Iron Founders' Society, held at the Edgewater Beach Hotel in Chicago, in announcing that the United States Patent Office has recognized the nature of these inventions by granting Patent Nos. 2,485,760 and 2,485,761 to the International Nickel Co.

★ ★ ★

**DR. IRVING LANGMUIR, associate director of the General Electric Research Laboratory, on Oct. 27 became the second American scientist to receive the Mascart Medal. This is awarded triennially by the French electrical engineering society, the *Societe Francaise des Electriciens*, to a scholar or engineer in any country "who is distinguished by an ensemble of works on pure or applied electricity."**

★ ★ ★

EIGHT ELEVATORS capable of a speed of 1,000 fpm, and six with a speed of 800 fpm, will be installed in the new office building of the Aluminum Co. of America at Pittsburgh by the Westinghouse Electric Corp.

In addition to the 14 high-speed elevators, Westinghouse will also install a signal-control passenger elevator for service between the sub-basement and the top floor, and an electric stairway between the basement and the first floor. The Selectomatic control system will be used for the high speed passenger elevators.

★ ★ ★

EFFECTIVE WRITING—whether in a letter, a newspaper or a technical magazine—makes understanding quick and easy for the reader. Commenting on this, W. H. Butterfield in *Credit World*, reviews the experience of the plumber who wrote to one of the Government Bureaus.

He said he found that hydrochloric acid opens plugged pipes quickly, and asked whether it was a good thing to use. A scientist at the Bureau replied as follows:

"The uncertain reactive processes of hydrochloric acid place pipe in jeopardy when alkalinity is involved. The efficacy of this solution is indisputable, but the corrosive residue is incompatible with metallic permanence."

The plumber wrote back, thanking the Bureau for telling him this method was all right. The scientist was disturbed about the misunderstanding, and showed the correspondence to his boss—another scientist—who immediately wrote the plumber:

"Hydrochloric acid generates a toxic and noxious residue which will produce submuriate invalidating reactions. Consequently, some alternative procedure is preferable."

The plumber wrote back that he agreed with the Bureau—hydrochloric acid works just fine. Greatly disturbed, the two scientists took their problem to the top boss. The next day the plumber received this telegram:

"Don't use hydrochloric acid. It eats hell out of the pipes."

# Fact File on Preheat

No. 6

Cheaper grades of fuel can be used with the Ljungstrom air preheater. For in the Ljungstrom regenerative design heat does not pass through the metal. The elements therefore operate at a higher temperature . . . approximately a mean between the air and gas temperature. This permits safe operation at high recovery rates even with low grade or definitely corrosive fuels.

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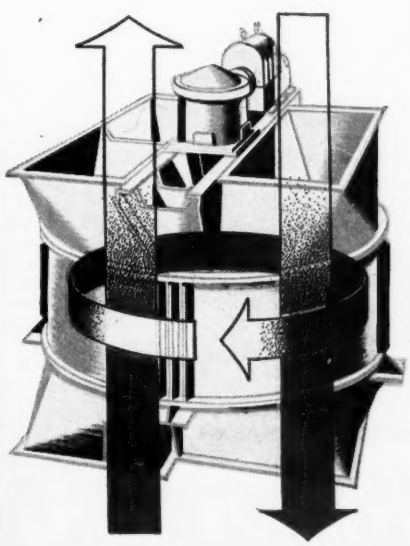

The Ljungstrom Air Preheater is a compact gas-to-air or gas-to-gas heat exchanger, operating on a continuous regenerative counterflow basis. Hundreds of leading power plants and other special applications confirm its high level of heat recovery and long-term low maintenance service.

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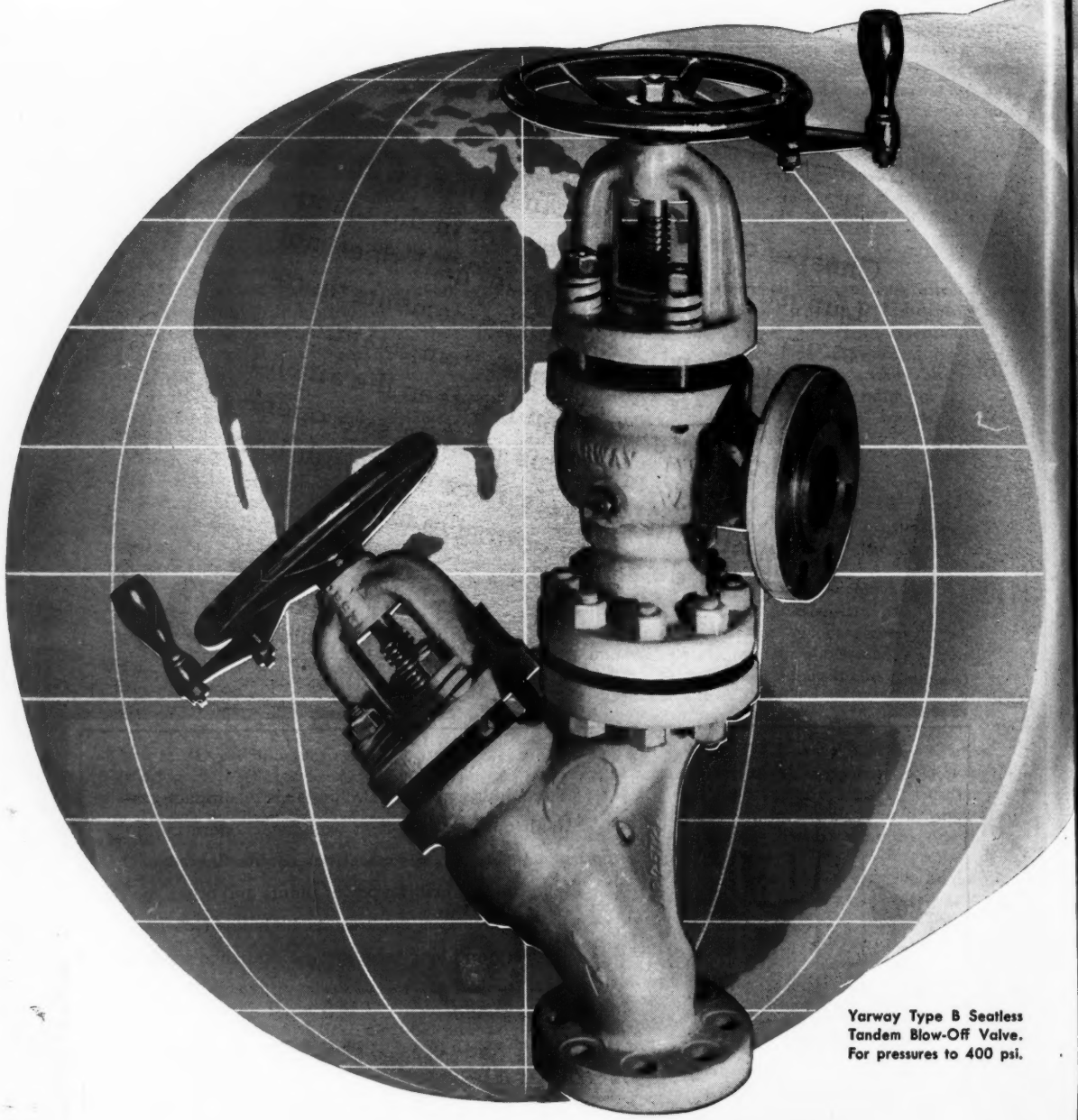

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For pressures to 400 psi.

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Partly because of Yarway's advanced designs—such as the Unit Tandem for high pressure work: This valve combines a Yarway *Stellite-Seat* Valve (for blowing) with a Yarway *Seatless* Valve (for sealing) in a solid, one piece forged-steel body.

And finally the dependable, trouble-free service of Yarway Blow-Off Valves prompts power plant engineers to insist on Yarways.

Regardless of the reason, the fact remains that today Yarway Valves are on the job—doing a good job—in more than 15,000 plants. How about yours?

Write for Bulletin B-424 for pressures to 400 psi. For higher pressures ask for B-432.

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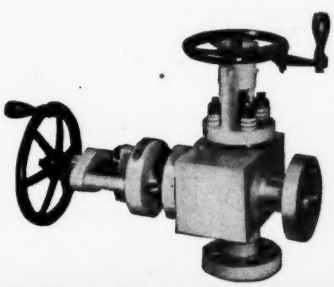
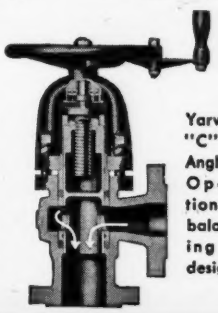


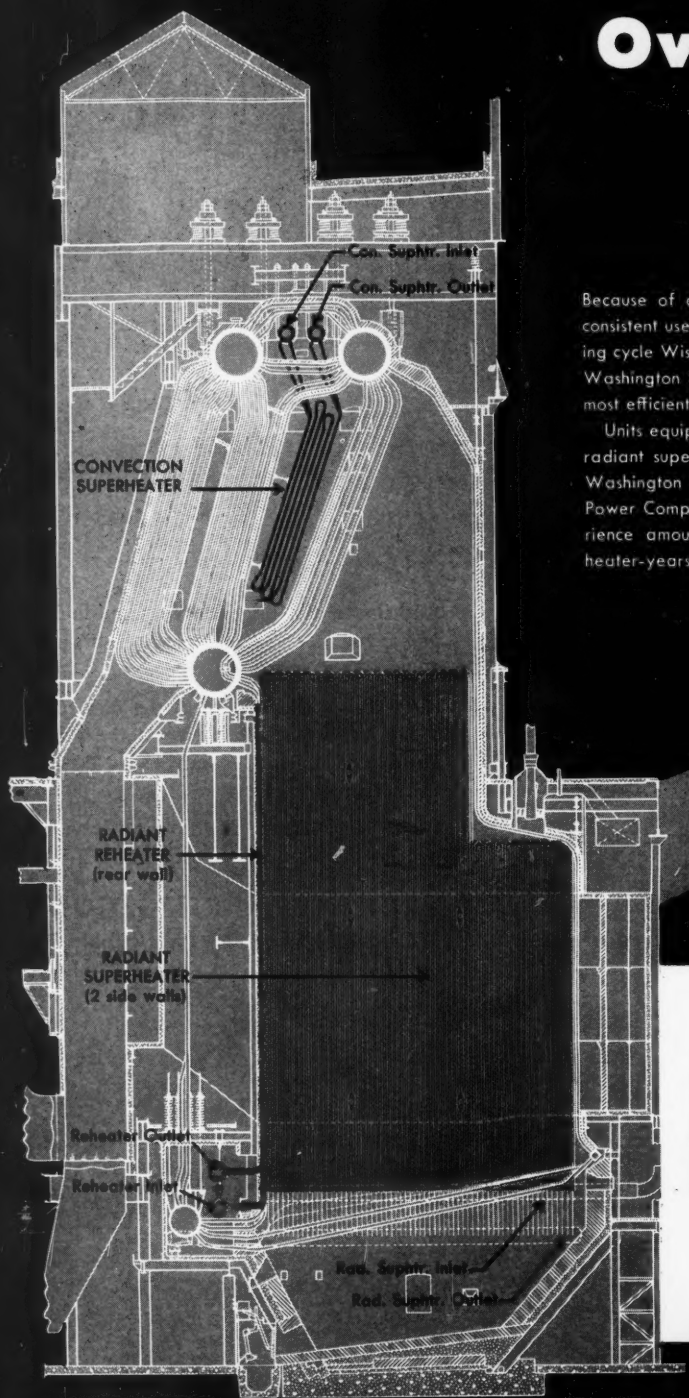
Yarway Unit Tandem Blow-Off Valve. Flanged type. Also available with welding ends. For pressures up to 2500 psi.



Yarway Type "C" Seatless Angle Valve. Open position. Notice balanced sliding plunger design.

Yarway Stellite-Seat Straightway Valve. Open Position.

# Over 500

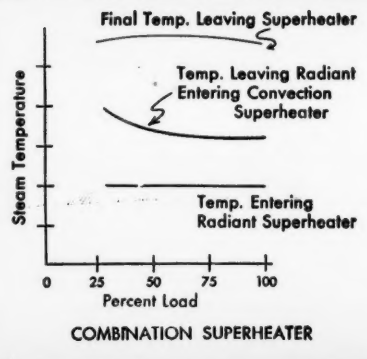



Because of a farsighted program involving the consistent use of a high temperature resuperheating cycle Wisconsin Electric Power Company's Port Washington Station is today one of the country's most efficient power plants.

Units equipped with FW radiant reheaters and radiant superheaters at both Lakeside and Port Washington Stations of the Wisconsin Electric Power Company show a total of successful experience amounting to over 500 "radiant superheater-years."

1949

FOSTER




COMBINATION SUPERHEATER

Fig. 1
*Note flat final steam temperature*

FOSTER WHEELER CORPORATION

# " superheater-years"

## in one utility alone*

*See TRANSACTIONS of the ASME, August, 1949, page 738.

1948 1943 1935 1929

**WHEELER RADIANT REHEATERS and SUPERHEATERS**

Foster Wheeler experience in the design and operation of radiant and convection surface dates from 1902 with the introduction of commercial use of superheated steam into the United States. ***A wider selection of fuels*** for resuperheating units may be obtained by using superheaters and reheaters which include FW radiant heat absorbing sections. This is in sharp contrast to the all convection type which will provide a wide range of steam temperature control at the risk of considerable slagging in both furnace and hotter convection zones. This also applies in the case of non-reheat units with wide control ranges. Performance data on units equipped with FW radiant surfaces for superheating and resuperheating at the Lakeside and Port Washington Stations of the Wisconsin Electric Power Company also testify to such advantages as ***a very high operating reliability*** and ***the compensating effect in temperature characteristics*** as against exclusively convection arrangements with steep load temperature curves (see figures 1 and 2). The fact that 35.6% of the total BTU duty on Unit No. 5 at Port Washington will be performed by the superheater and reheater well illustrates the magnitude of this function of a modern steam generator.

To date, four units incorporating FW radiant reheating and radiant and convection superheaters have been installed in the Port Washington Station. The fourth unit was started in August 1949 and a fifth is in fabrication. The combined availability of the first three operating units, the initial one of which was installed in 1936, is 95% for a total of 147,235 hours of service as of December 26th, 1948.

***For further information,*** write for Paper No. 48-A-120

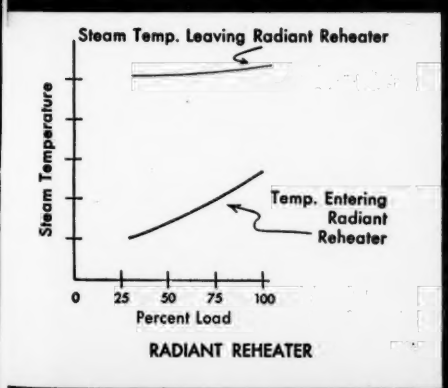
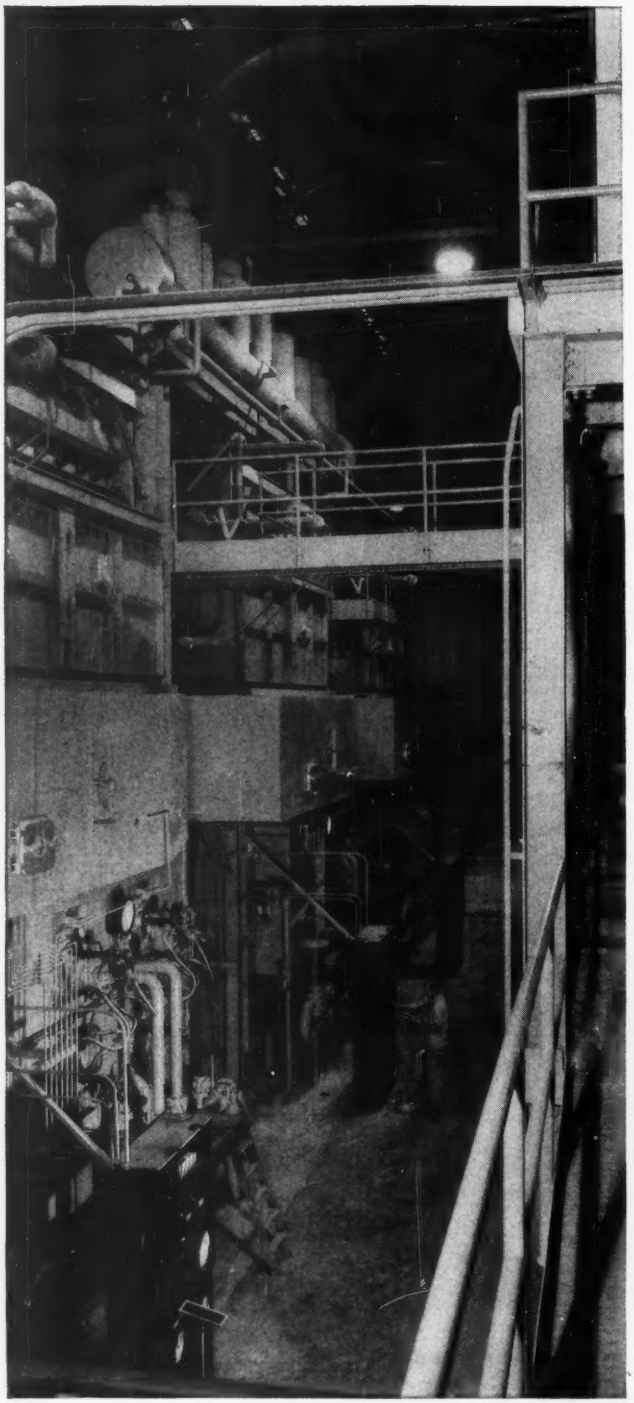



Fig. 2
*characteristics over wide load ranges*

165 BROADWAY, NEW YORK 6, N.Y.

# COMBUSTION CONTROL



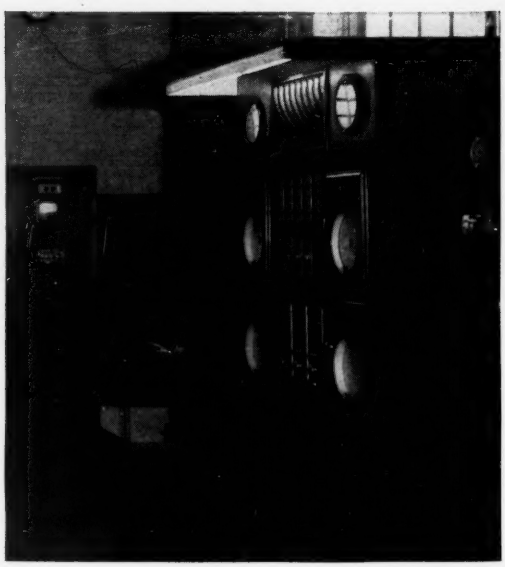
## *FOR*
## ALL SIZES OF BOILERS
## ALL TYPES OF FIRING
## ALL LOAD CONDITIONS

An automatic combustion control system, as designed and built by Republic, will enable you to operate your boiler (or boilers) over a long period at test efficiencies regardless of variations in fuel, load and other operating factors.

Republic combustion control is a unified system controlling simultaneously, in measured quantities and in correct proportions, the fuel and air input to the boiler.

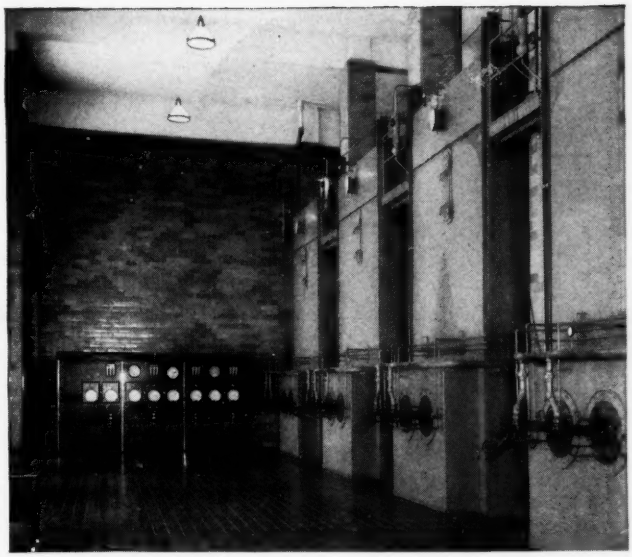
It automatically increases or decreases the fuel and air supply to the boiler in the correct amount to maintain constant steam pressure and in the correct ratio to maintain maximum combustion efficiency.

Republic automatic combustion control systems, either pneumatic or hydraulic, are available for all sizes of boilers, all types of fuel firing, and load conditions and any arrangement of draft equipment. They are completely described in Data Book No. S-21—write for your copy.

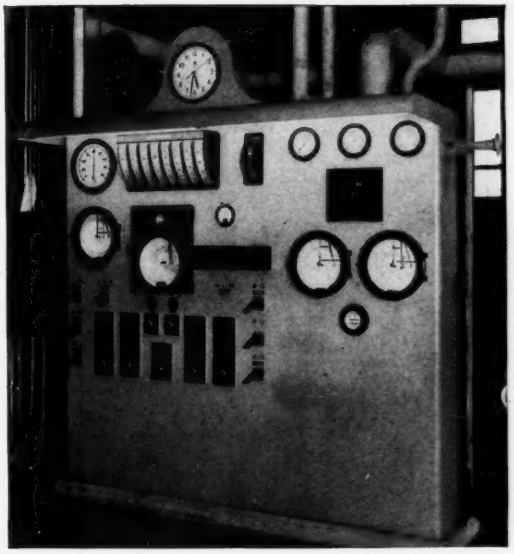


**GAS FIRED**—In this modern industrial plant steam is generated at the rate of 400,000 lbs. per hr. by four gas fired boilers operated by a Republic automatic combustion control system.

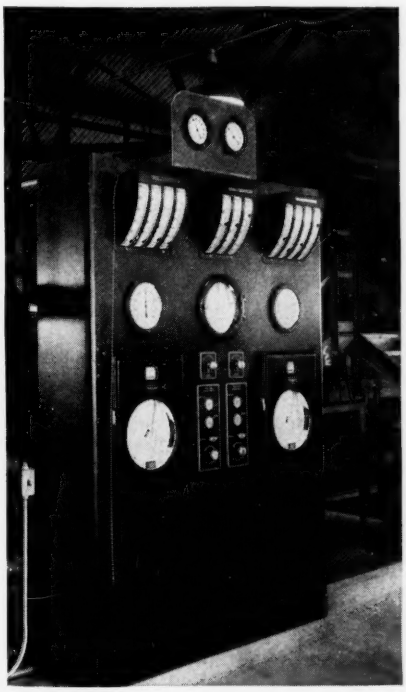
**STOKER FIRED**—The Republic instrument and combustion control panel for an 80,000 lbs. per hr., stoker fired boiler in a municipal power plant.



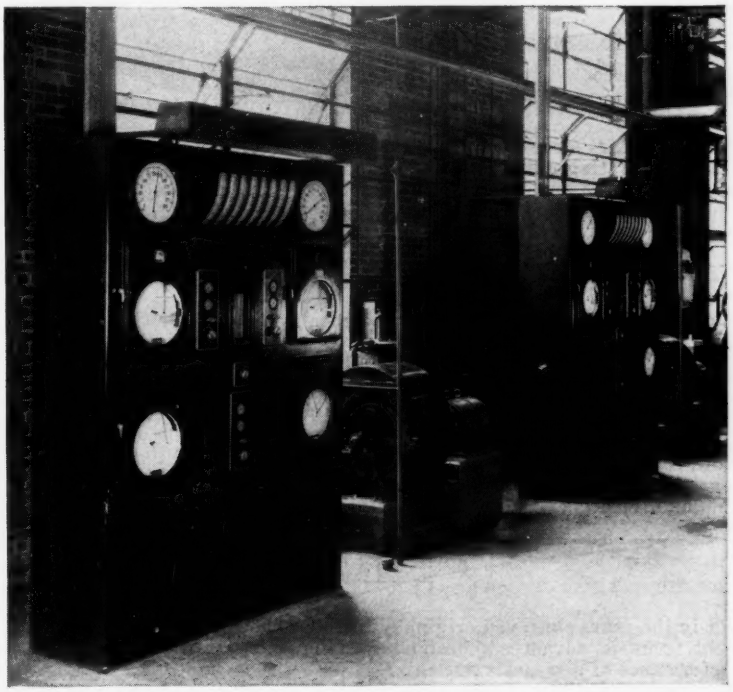
**OIL AND GAS FIRED**—In this model boiler room of a large institution the four combination oil and gas fired boilers are operated by a Republic automatic combustion control system.



**STOKER FIRED**—The Republic combustion control and instrument panel for the automatic operation of a 45,000 lbs. per hr. stoker fired boiler.



**MIXED GAS**—Republic instrument and control panel installed in a natural gasoline plant to automatically control two 50,000 lbs. per hr. boilers burning mixed gas.



**STOKER FIRED**—A typical Republic combustion control installation in the boiler room of a mid-western university for the automatic operation of two 25,000 lbs. per hr. stoker fired boilers. All boiler instruments and manual controls are centralized on the two panels pictured above.

**REPUBLIC FLOW METERS CO.**

**2240 Diversey Parkway, Chicago 47, Illinois**

PRIMER FOR PROFIT

# When is a steam plant old?

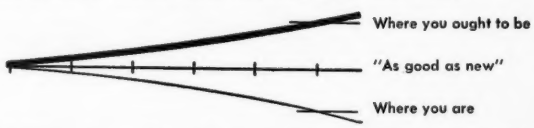
Calendar years alone do not tell the complete story of a steam generating unit's age. For instance, if you have a 25-year old unit, and disregard normal deterioration, you could chart the years like this:

but in that time its effectiveness has probably fallen off like this:

Now, rehabilitation *could* restore it to what is commonly regarded as "As good as new condition" by general overhaul and replacement of all worn out parts:

But in the years since you originally installed the equipment, technical advances in design have improved overall performance of new units like this:

So "as good as new" isn't good enough. It won't bring your unit up to the performance possible with a modern unit. Your situation may actually look like this:




The upper curve above shows the performance possible with a new unit. But only modernization can bring you to that point.

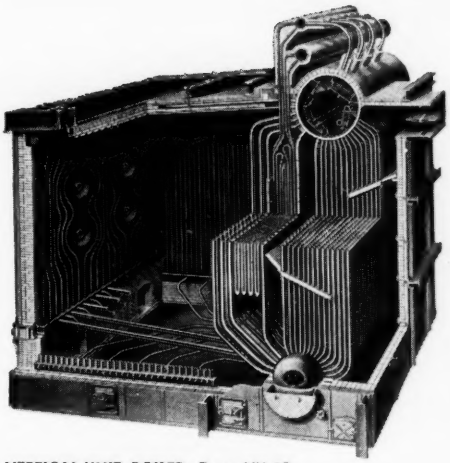
The improved overall performance of modern steam generating and fuel burning equipment—plus the increased cost of both fuel and labor—have actually accelerated the rate of obsolescence of your equipment . . . have hastened the day when replacement will pay handsome dividends.

The chances are that steam plant modernization will cut *your* overall production costs . . . will help *you* solve today's most difficult problem—the diminishing margin between selling price and operating costs.

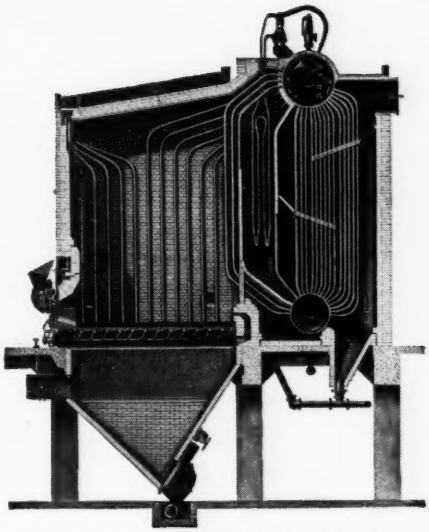
Modern boiler equipment, like that shown on the opposite page, is the answer to the problem of bringing your steam plant performance up to the best modern standard. Combustion's years of experience are yours for the asking—no obligation, of course. B-346

**COMBUSTION ENGINEERING**

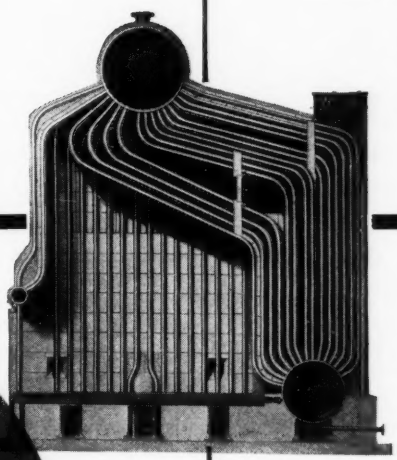
A MERGER OF COMBUSTION ENGINEERING COMPANY INC AND THE SUPERHEATER COMPANY



**C-E VERTICAL-UNIT BOILER, Type VU-50**
*For higher capacity requirements. Designed for firing by pulverized coal, oil or gas alone or in any combination.*



**C-E VERTICAL-UNIT BOILER, Type VU-30**
*For medium capacity requirements. Adapted to the use of any type of mechanical stoker or oil or gas.*



**C-E VERTICAL-UNIT BOILER, Type VU-10**
*For smaller plants and those having limited operating personnel. May be fired by C-E Underfeed, Spreader or Traveling Grate Stokers or oil or gas.*

# C-E VERTICAL UNIT BOILERS

If the story on the opposite page applies to your plant—if the combination of normal and accelerated obsolescence has brought your equipment to where it will be less expensive (in the long run) to replace it than to keep it—then the C-E Vertical-Unit Boiler line may well offer the right answer to your situation. For here is a group of carefully engineered and standardized units that represent the best modern standards in steam generating equipment.

The three boilers illustrated—and others in the line not shown—are collectively designed to serve virtually every industrial requirement from about 10,000 to 300,000 (or more) lb of steam per hour, pressures up to 1,000 psi and steam temperatures to 900 F. The entire Vertical-Unit line offers the advantages of time-tested standards of design coupled with that flexibility of application—fuels, firing methods, operating conditions, etc.—required to meet particular plant needs. We shall be pleased to supply catalogs and any additional information required upon request.

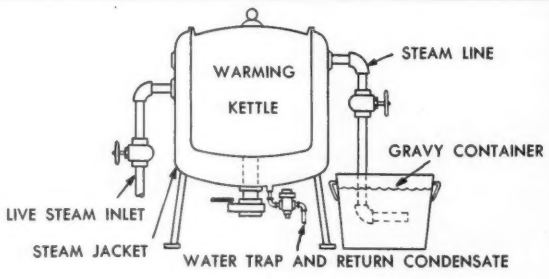
## —SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

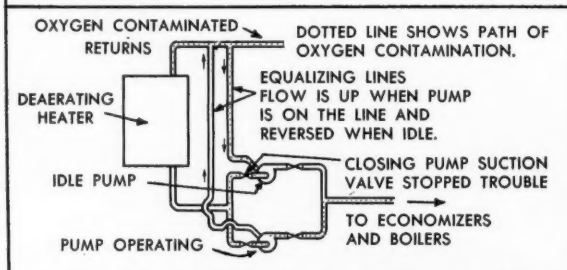
# PERIODIC VISITS BY
# Hall Service Engineers

The Hall service engineer who visits your plant periodically, as provided in the Hall contract, checks boiler water conditioning procedures with you, as a matter of course. Often, he is able in this way to "head off" trouble before it starts. That is not the end of his work, however, for he is prepared to help in virtually any problem connected with generating and using steam—and sometimes he traces trouble to an unexpected source.

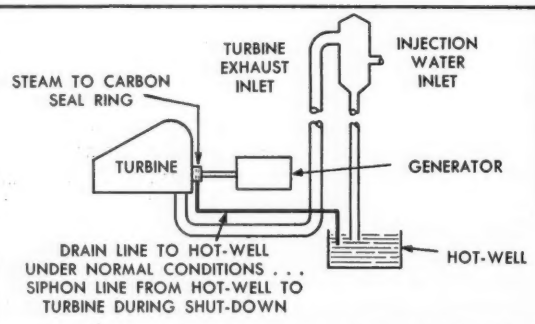
1. In one plant the boiler water was OK by plant tests, but the Hall engineer was sure that phosphate feed was too high. Checking, he found that phosphate tests were being made with too weak a test solution — and consequently showed less phosphate in the water than was actually present. Correcting this saved the client many dollars every day.




2. In another plant, where foaming occurred at frequent intervals, tests of the water at these times showed the presence of organic contamination. The Hall engineer traced this contamination to an "impossible" source—the plant cafeteria. On occasion, gravy was sucked back into the return condensate, by way of the steam jacket around a warming kettle!


OXYGEN CONTAMINATED RETURNS
DOTTED LINE SHOWS PATH OF OXYGEN CONTAMINATION.
EQUALIZING LINES FLOW IS UP WHEN PUMP IS ON THE LINE AND REVERSED WHEN IDLE.
DEAERATING HEATER
CLOSING PUMP SUCTION VALVE STOPPED TROUBLE
IDLE PUMP
TO ECONOMIZERS AND BOILERS
PUMP OPERATING

3. At still another plant, increasing sodium sulphite consumption indicated to the Hall engineer that oxygen contamination was taking place. He traced this to a feed pump, and then the plant engineer remembered a feature of the piping arrangement which would, when one pump was idle, permit oxygen-contaminated condensate to leak into the pump suction. Closing a valve on the idle pump ended the difficulty.


TURBINE EXHAUST INLET
INJECTION WATER INLET
STEAM TO CARBON SEAL RING
TURBINE
GENERATOR
DRAIN LINE TO HOT-WELL UNDER NORMAL CONDITIONS . . . SIPHON LINE FROM HOT-WELL TO TURBINE DURING SHUT-DOWN
HOT-WELL

4. In a New York brewery, pitting of turbine blades was blamed on carry-over of sodium chloride in the steam. Hall engineers were not satisfied merely to prove that the steam was pure, but also showed that the pitting occurred when the turbine was idle. Following this lead, it was found that the drains from the turbine seal rings were piped into the barometric condenser hot well, which contained salt water. When steam condensed, brine was siphoned into the turbine.

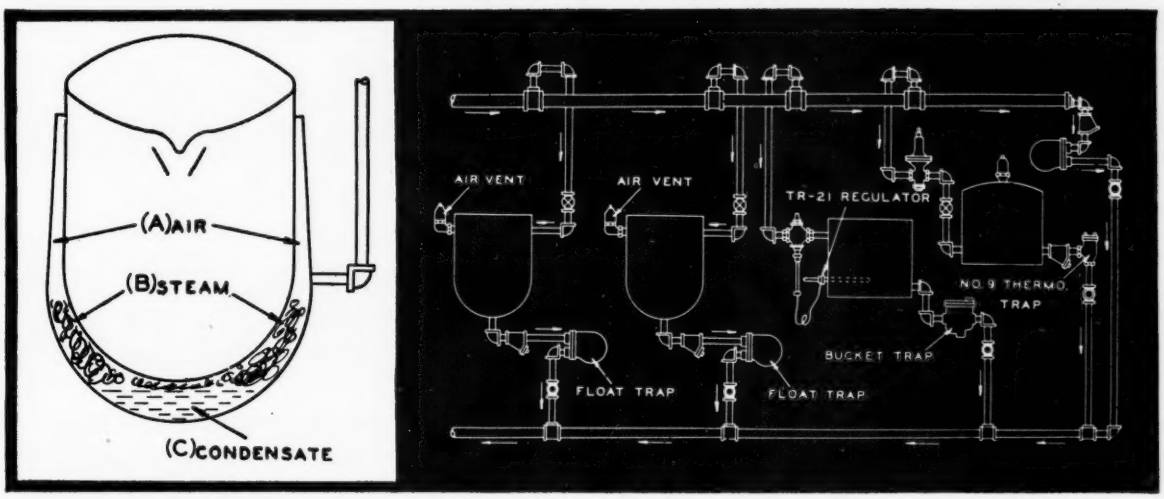
These incidents illustrate some of the varied ways in which Hall engineers help Hall clients, even when the boiler water conditioning is not involved. They also illustrate why so many plants, year after year, continue to use Hall service.

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

**HALL LABORATORIES, INC.**

*(A Subsidiary of Hagan Corporation)*

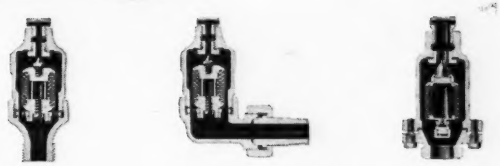
CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL




# GOOD STEAM PRACTICE

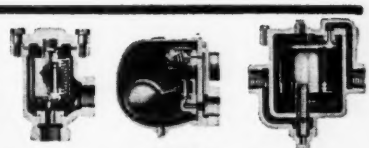
## *Simple as* A B C

**A.** Air and other gases in steam lines or equipment not only reduce the effective temperature of the steam, but create insulated cold spots wherever there is an accumulation. These gases are constantly generated in the boiler and air is always present when starting up. Ask for Bulletin No. 275 (Air in Steam).



**B.** Dry steam can be delivered at the point of use only by trapping condensate from mains, risers, coils, etc. The amount of steam and therefore the temperature of the room, process, press, tank or oven, can be controlled to within a degree or two by selecting suitable Sarco Temperature Controls.

**C.** The speed of the work can be maintained and fuel efficiency insured at top level by removing condensate with the right Sarco Steam Trap based on calculations and recommendations given in Sarco Bulletin No. 1600.



No. 9 — FLOAT THERMOSTATIC — BUCKET

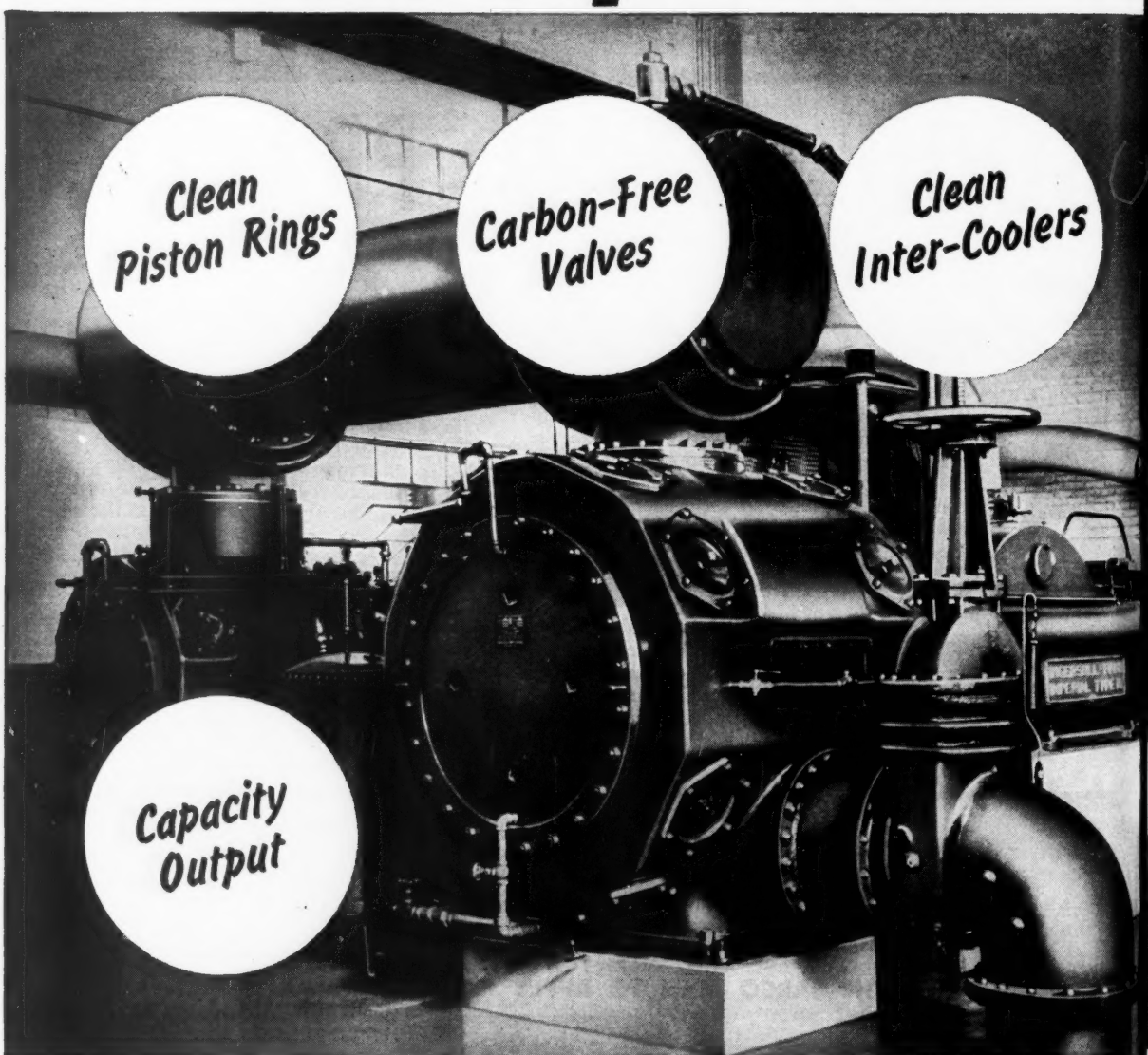
**ASK THE SARCO MAN TO APPLY "ABC" TO YOUR PLANT**

**SARCO SAVES STEAM**

**SARCO COMPANY, INC.**
*Represented in Principal Cities*
Empire State Building, New York 1, N. Y.
SARCO CANADA, LTD., TORONTO 5, ONTARIO

IMPROVES PRODUCT QUALITY AND OUTPUT

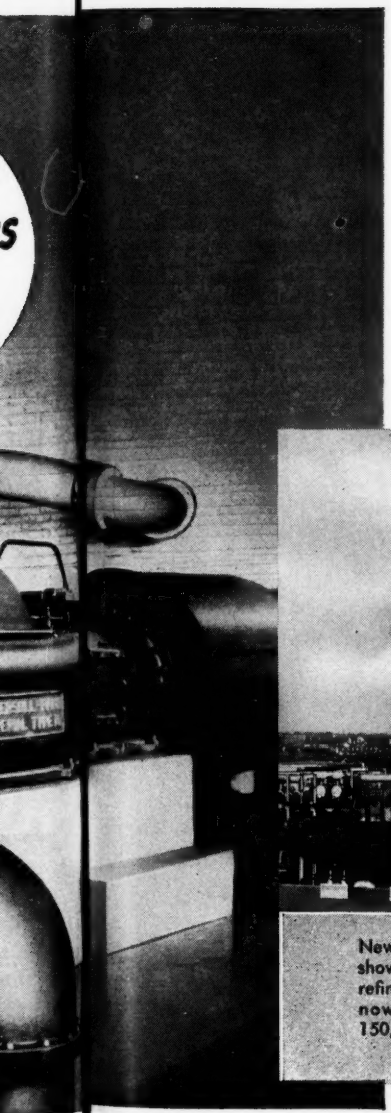
# TROUBLE-FREE
# Under Any Pressure




SINCLAIR

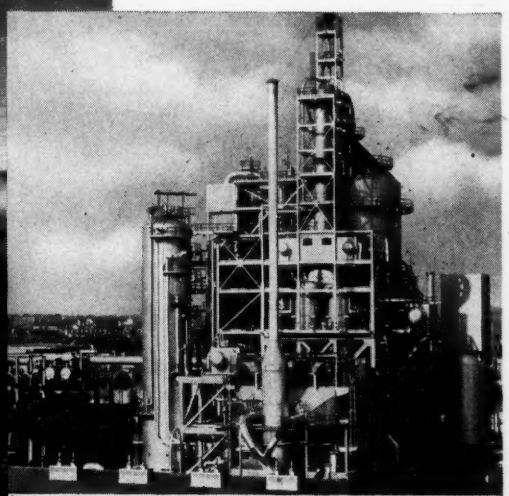
YOUR NEAREST SUPPLIER OF SINCLAIR PRODUCTS WILL GLADLY ARRANGE

# Compressor Operation with Sinclair Rubilene



In many industries positive supply of air is a vital necessity . . . which means that reliable compressor performance is imperative.

With Sinclair RUBILENE, an operator can be confident of uninterrupted performance. RUBILENE has the ability to resist oxidation under high temperatures, to reduce carbon and sludging and to keep sustained lubricating quality through long service. It assures full capacity output by keeping valves and rings clean and free. For positive lubrication, better try RUBILENE.



New Fluid Catalytic Cracking Stills (like the one shown here) are helping to expand Sinclair's refinery output. Sinclair's great refineries are now turning out products at the rate of 150,000,000 gallons of lubricating oil yearly.

About 40% of all the Aircraft Engine Oil used by domestic Airlines in the U.S.A. is supplied by SINCLAIR. The same careful research that developed this high quality oil for the Airlines is put into RUBILENE and other Sinclair Oils.

## INDUSTRIAL OILS

FOR LUBRICATION COUNSEL, OR YOU MAY WRITE TO SINCLAIR REFINING COMPANY, 630 FIFTH AVE., NEW YORK 20, N. Y.

# A TRIBUTE TO BEAVERS' SKILL

## But "Reverse Flow" Can Prevent it in Condensers

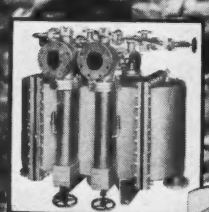
Many a stream has been reduced to a trickle and even stopped by dam-building "eager beavers." Look at the efficient job they did on this one, using all kinds of debris—twigs, sticks, grass, stones, mud, etc. This dam may be useful to the beavers but a power plant operator has troubles galore when such debris hampers the flow of condenser cooling water, causing loss of vacuum. But these are needless troubles when you can have C. H. W. patented "Reverse Flow" condensers. Just by opening and closing valves with push button control, you can reverse the flow of water through the tubes, thus flushing out debris that gets through the water screens. Depending upon the condition of the cooling water, C. H. W. "Reverse Flow" condensers have gone two years and longer before requiring cleaning. What's more, in the divided water box type shown here, you don't have to completely shut down your operations, since one-half can be cleaned at a time while the other half is operating. These economies—continuous peak efficiency and almost no clean-ing costs—pay for C. H. W. "Reverse Flow" in an amazingly short time. A great many are now operating in sizes ranging from 10,000 sq. ft. to 50,000 sq. ft. Write for more information on how to prevent "damming up" of your condenser tubes.

**C. H. WHEELER MANUFACTURING CO.**

**1802 Sedgley Avenue, Philadelphia 32, Penna.**

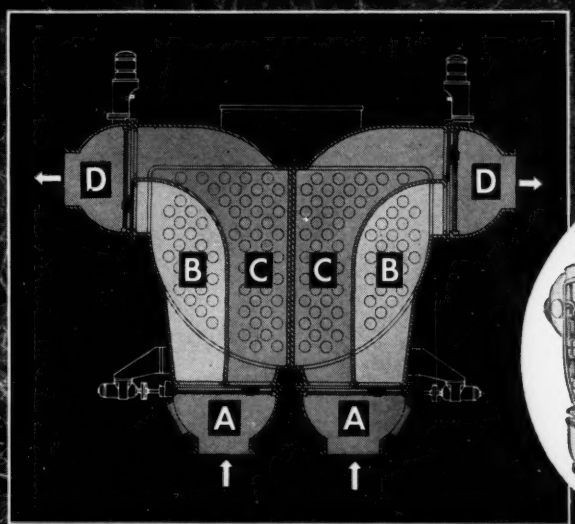
REPRESENTATIVES IN MOST PRINCIPAL CITIES

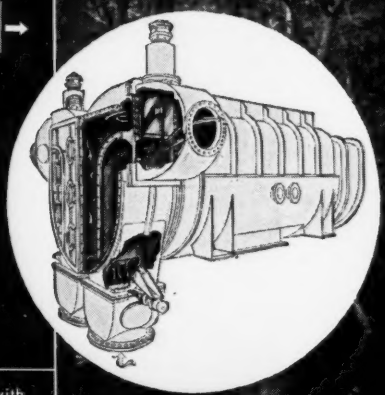
SINCE 1903



Steam Jet Ejectors (top) for surface condensers and single and multi-stage ejectors for process applications. Water cooling towers for process, power and air conditioning applications where water is recirculated. Catalogs on request.

C. H. Wheeler



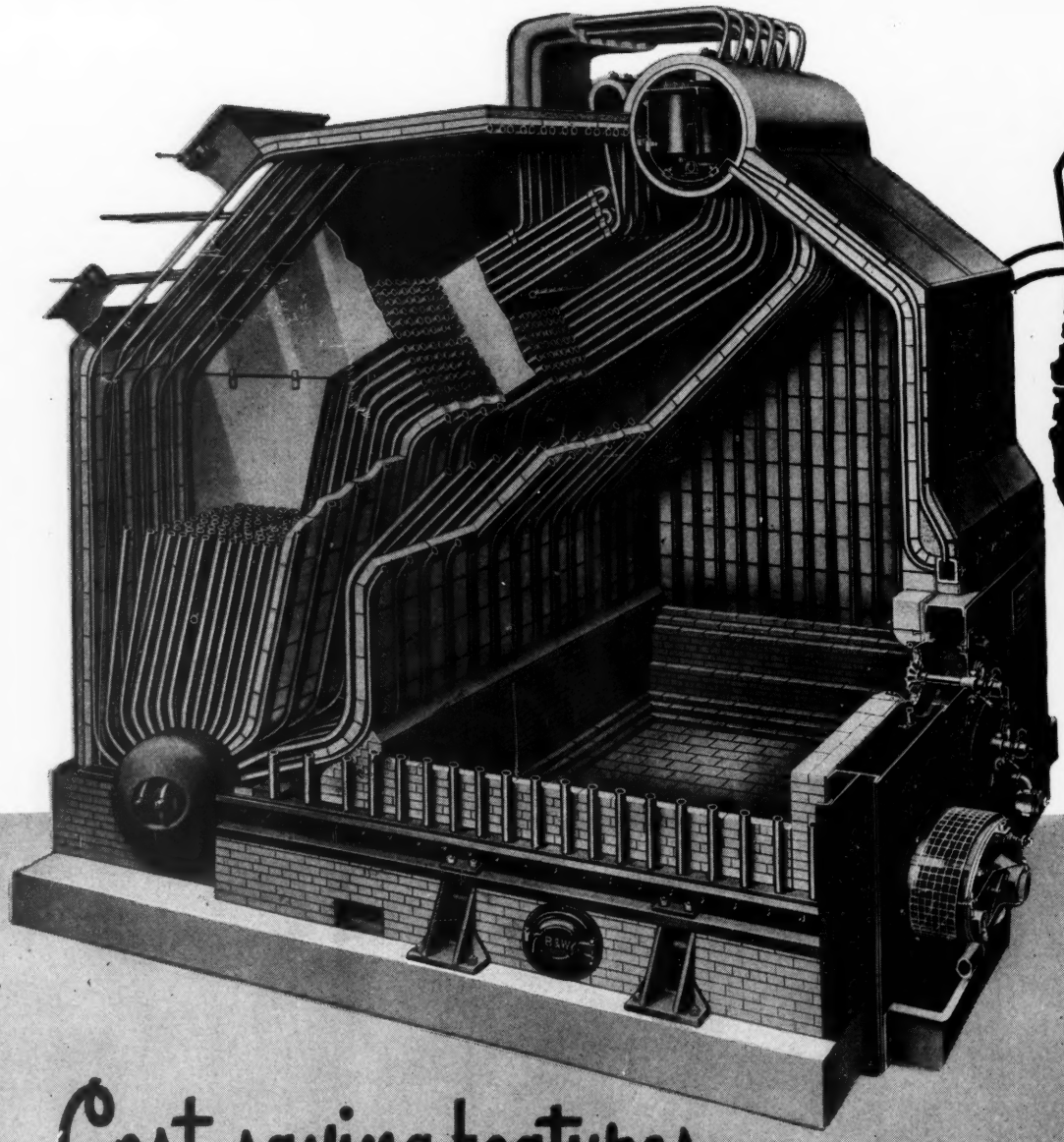



In the operation of a C. H. W. "Reverse Flow" Condenser, with divided water box, water enters valve chamber at A with left hand valve port open to permit water to flow through pass B, then changing direction at other end of condenser and flowing back through pass C and out through the upper port of D. To reverse flow, valves at inlet A and discharge D are changed to permit water to flow through C first, returning through B and out through the lower port of D. Both halves of the condenser are operated in similar manner, but independently of each other.

NG GALLOWAY, N. Y.

TEAM CONDENSERS • WATER COOLING TOWERS
JECTORS • STEAM JET VACUUM REFRIGERATION

OF PHILADELPHIA

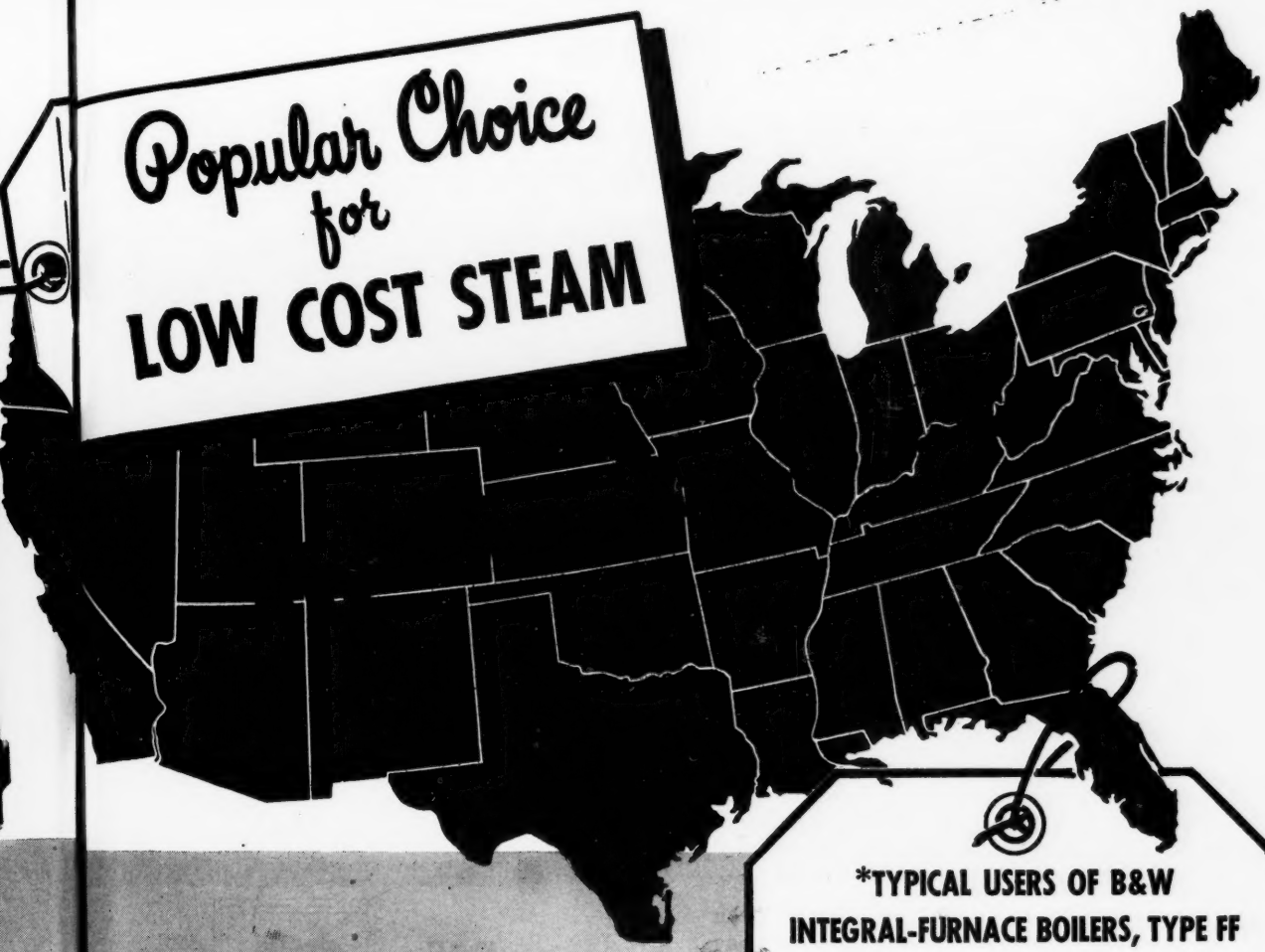


# Cost saving features

## OF B&W INTEGRAL-FURNACE BOILER, TYPE FF

- Moderate first cost
- Minimum floor space and headroom requirements
- High fuel economy
- Smokeless combustion
- Adaptable to all fuels and firing methods
- Economical fast steaming
- Water-cooled furnace
- Clean, dry steam at all ratings even with high boiler water concentrations
- Quick response to wide and heavy load swing demands
- Easy to inspect and clean
- High availability with least attention

# Popular Choice for LOW COST STEAM



It's the B&W Integral-Furnace Boiler, Type FF . . . the self-contained, compact unit that is piling up highly impressive records for economical and dependable steam generation in hundreds of widely diversified installations* all over the Nation. Operating and maintenance features listed on the opposite page indicate why this completely coordinated, standardized design has earned the confidence of industries, utilities, and other users requiring boiler capacities up to 60,000 lb. per hr. at pressures above 160 psi.

It will pay you, as it has so many others, to investigate the advantages of this outstanding B&W boiler. Begin by asking for Bulletin G-64.

BABCOCK & WILCOX

## *TYPICAL USERS OF B&W INTEGRAL-FURNACE BOILERS, TYPE FF

**INDUSTRIES**

Abrasives
Airlines
Automotive
Baking
Beverages
Brewing
Building Materials
Candy
Chemicals
Dairy
Distilling
Drugs
Electrical
Electronics
Food
Foundry
Fruit Packing
Glass
Iron & Steel
Laundry
Leather
Lumber
Machinery
Meat Packing
Metal Working
Mining
Non-Ferrous Metal
Oil Refining
Paint
Paper
Plastics
Process
Railroad
Rubber
Sugar
Textile
Tobacco

**UTILITIES**

Gas Companies
Municipal Plants
Power Plants

**OTHERS**

Colleges
Florists
Hospitals
Hotels
Housing Projects
Institutions
Military Posts
Navy Yards
Office Buildings
Ordnance Plants
Stores

G-467

# Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE
LOSS OF FUEL ECONOMY
BAD COMMUNITY RELATIONS

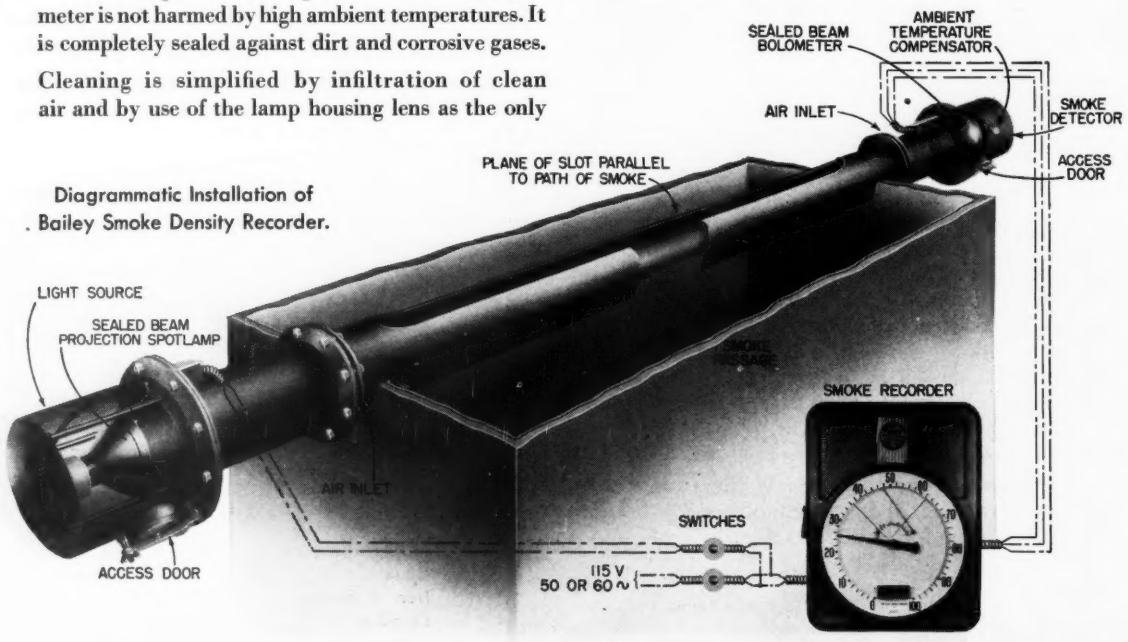
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".




Diagrammatic Installation of Bailey Smoke Density Recorder.

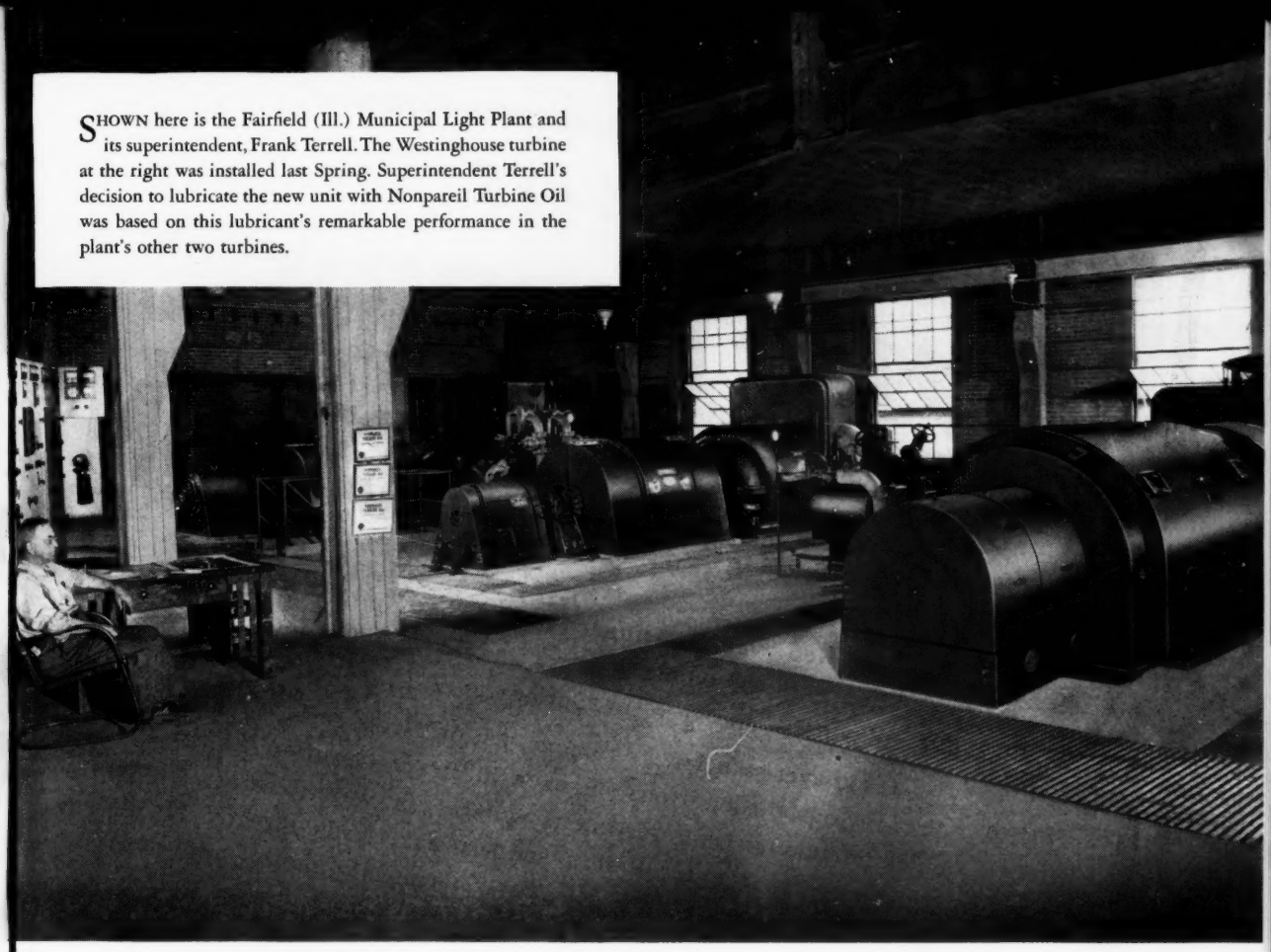
G-29

**BAILEY METER COMPANY**

1040 IVANHOE ROAD, CLEVELAND 10, OHIO • BRANCH OFFICES IN PRINCIPAL CITIES

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

*Let Bailey Smoke Density Recorders Watch Your Stacks*



SHOWN here is the Fairfield (Ill.) Municipal Light Plant and its superintendent, Frank Terrell. The Westinghouse turbine at the right was installed last Spring. Superintendent Terrell's decision to lubricate the new unit with Nonpareil Turbine Oil was based on this lubricant's remarkable performance in the plant's other two turbines.

# Here's minimum turbine-oil maintenance

CENTRIFUGING once a year is the only turbine-oil maintenance found necessary at the Fairfield Municipal Light Plant, Fairfield, Illinois. This practice has been followed ever since 1940, when Nonpareil Turbine Oil first went into the plant's new 1500-KW Westinghouse turbine. The same routine has been employed on a second Westinghouse unit of 2500 KW, installed in 1942.

During these 8 and 10 years of operation, the original fills of Nonpareil have not been removed either for treating or for replacing. Neutralization numbers have stayed below 0.08 mg KOH/gm. Oil systems have remained entirely clean.

Such lubricating economy and efficiency is not limited to 10- or 15-year records with Nonpareil Turbine Oil. Each fill of Nonpareil carries a written guarantee that it will remain below a neutralization number of 0.15 mg KOH/gm. *for the life of the turbine* it lubricates. 21-year service records of Nonpareil provide evidence of its ability to end acidity trouble and oil maintenance once and for all.

A Standard Oil Lubrication Engineer will be glad to supply you with actual case histories of utility operations in which Nonpareil Turbine Oil has reduced lubrication costs as much as 68%. Your letter will obtain the Engineer's services.

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

**NONPAREIL**
**Turbine Oil**

**"Will outlast your turbine"**

**STANDARD OIL COMPANY (INDIANA)** STANDARD

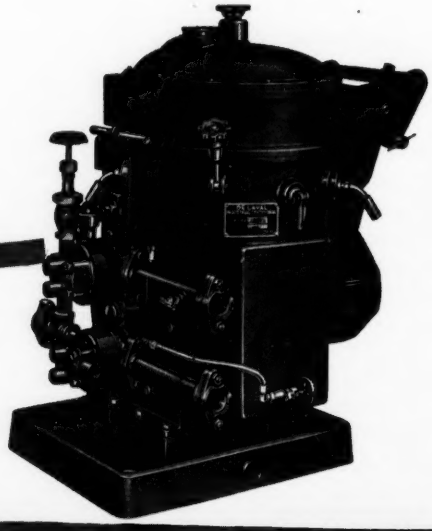
NO HALFWAY MEASURES

IN *my* TURBINE PROTECTION

"I am De Laval Centrifugal Force. When I protect a turbine my protection goes the whole distance. I remove **both** contaminants—***dirt*** and ***water***—and keep the lubricating oil at its best at all times."

It is never sufficient to remove just dirt from turbine oil. While dirt obviously soon ruins oil as a lubricant, as often as not the chief offender in that respect is ***water***. For water, either as condensate or in the form of a sudden leak, leads directly to the formation of sludge. It is also apt to emulsify the oil and cause serious difficulty in that way.

De Laval Oil Purifiers, wholly mechanical in action, remove dirt and continuously discharge the water, effecting separation by centrifugal force. The machines maintain full efficiency of purification right to the moment when the bowl is full of dirt and must be cleaned.

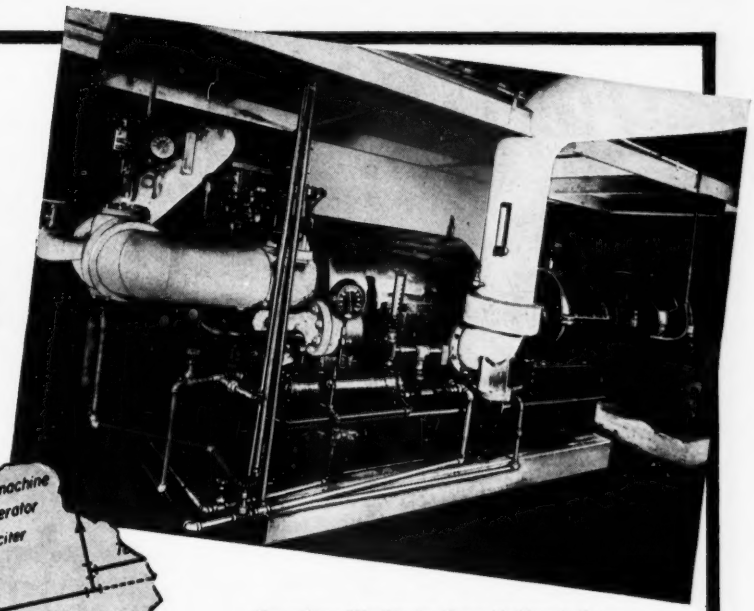


THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

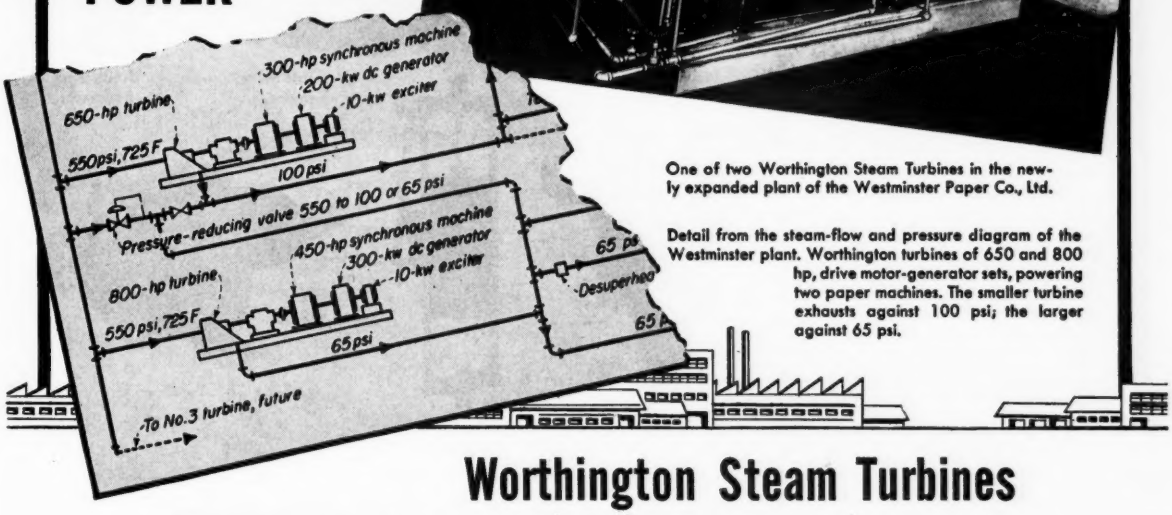
# De Laval

**OIL PURIFIERS** for more dependable power production

# CANADIAN PAPER PLANT MODERNIZES WITH FLEXIBLE, ECONOMICAL POWER



One of two Worthington Steam Turbines in the newly expanded plant of the Westminster Paper Co., Ltd.




Detail from the steam-flow and pressure diagram of the Westminster plant. Worthington turbines of 650 and 800 hp, drive motor-generator sets, powering two paper machines. The smaller turbine exhausts against 100 psi; the larger against 65 psi.

## Worthington Steam Turbines Chosen As Prime Movers In Novel Hook-Up

In an extensive modernization and expansion program at its plant in New Westminster, B. C., Canada, the Westminster Paper Co., Ltd. selected two Worthington Turbines as power-sources for its paper machines. (For operational data, see diagram.) Turbine speed of 4065 rpm is reduced by Worthington Reduction Gears to the motor-generator speed of 1200 rpm.

Synchronous machines, connected directly to the power system, may act as motors or generators, depending on requirements of the exhaust-steam systems — which, in turn, are controlled by backpressure governing of the turbines.

*Using Worthington Steam Turbines as reducing valves, as this plant does, produces the lowest cost power of any generating system.*

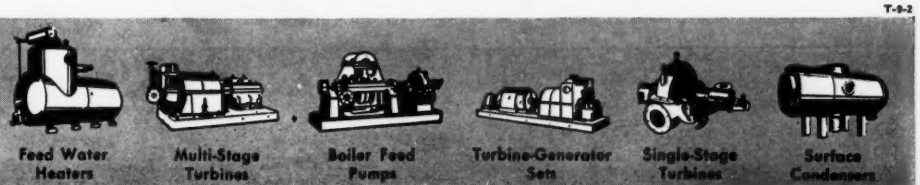
**For your own power applications** investigate the dependability, economy and *flexibility* of Worthington Turbines and Turbine-Generator Sets. For further proof of the *more worth in Worthington*, contact your nearest Worthington representative or district office. Or write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y*

**WORTHINGTON**

**STEAM TURBINES**

T-9-2

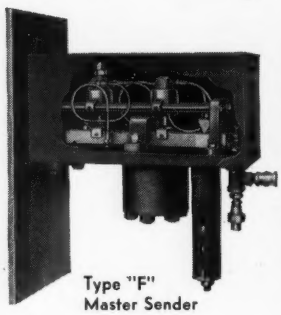
**A GREAT TEAM IN STEAM**



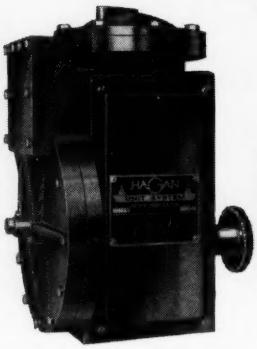
# *Equipment by* HAGAN

## FOR CONTROL SYSTEMS

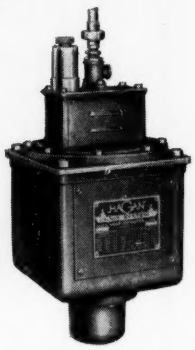
Hagan pioneered in the field of automatic combustion control systems for both stationary and marine boilers—and still leads. Engineering of these and other control systems is one of Hagan's major activities, but the components of these systems are suitable for many other applications, and may be purchased separately.



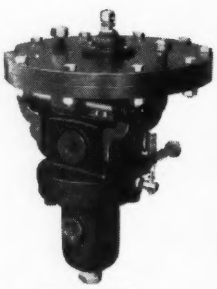
Type "F" Master Sender



Variable Ratio Regulator

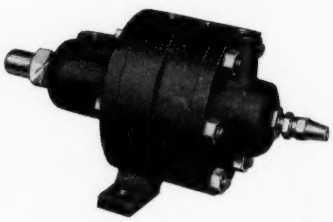


Diaphragm Regulator



Differential Transformer

Receiving Regulator

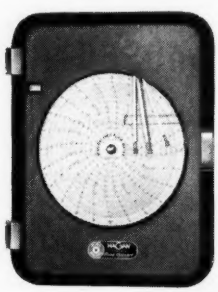


Type "F" Totalizer

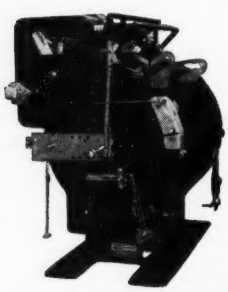
## FOR FLOW MEASUREMENT

The Hagan Ring Balance Flow Meter is a rugged and accurate instrument, adapted for a wide range of static and differential pressures. Calibration is the same for dry or wet service; range changing is exceptionally easy. Suitable for water, steam, air, gas, oil, and other fluids. *No stuffing boxes.* Calibration by dead weight method checks or takes the place of water column methods. Photos show a few typical models of this meter.

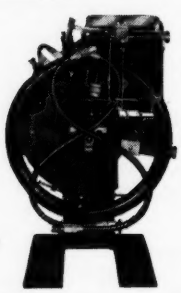
Ring Balance Flow Meter (Indicating)



Ring Balance Flow Meter (Integrating & Recording)



Dual Meter with Integrator (Case Removed)



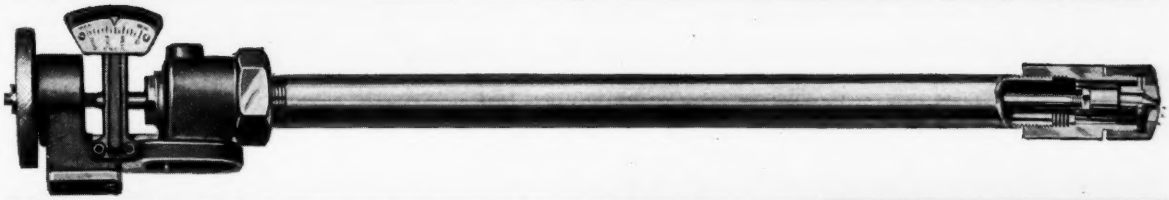
Single Ring Meter without Integrator (Rear View)

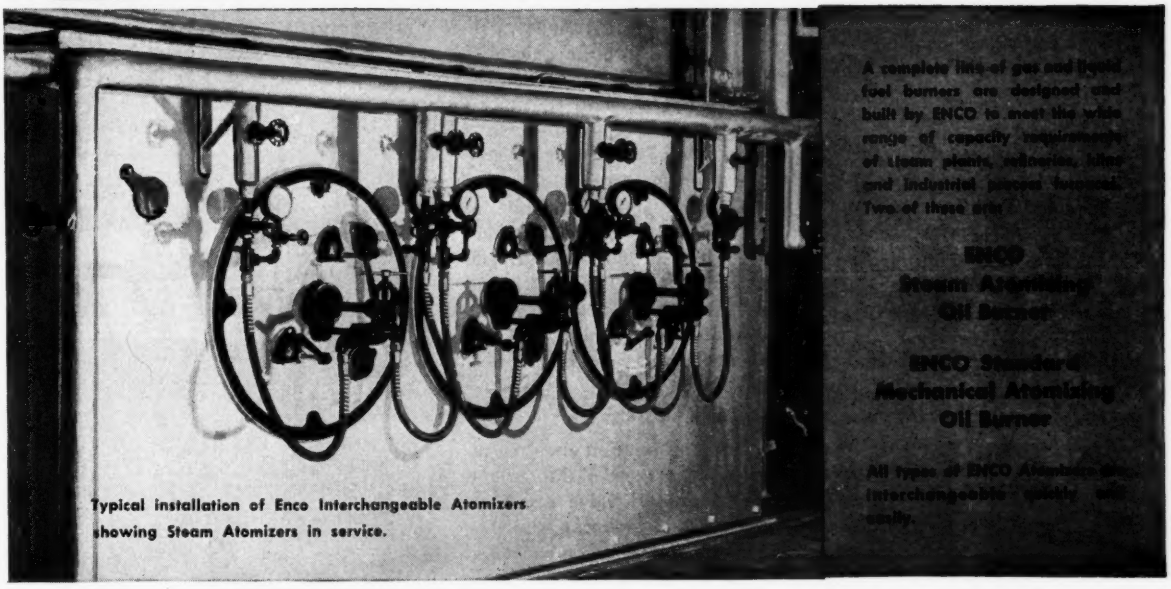
HAGAN
HALL
BUROMIN
CALGON

**HAGAN CORPORATION**

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

# ENCO WIDE RANGE Mechanical Atomizer





Typical installation of Enco Interchangeable Atomizers showing Steam Atomizers in service.

A complete line of gas and liquid fuel burners are designed and built by ENCO to meet the wide range of capacity requirements of steam plants, industrial, lime and industrial process furnaces. Two of these are:

**ENCO Steam Atomizing Oil Burner**

**ENCO Standard Mechanical Atomizing Oil Burner**

All types of ENCO Atomizers are interchangeable quickly and easily.

Designed to minimize operating troubles in either full load or ignition service, the Enco wide range mechanical atomizer will handle a capacity of 10 to 1 . . . without changing burner tips when using 300 psi oil pressure. This equals the performance of *five* ordinary atomizers.

Now used in many power plants throughout the country, the Enco wide range mechanical atomizer maintains a more constant velocity of oil through the atomizer, and utilizes the high oil pressure to insure efficient atomization over the entire load range. Large or small boilers can be brought on the line and carried up to full load operation without changing sprayer plates.

The Enco wide range mechanical atomizer can be controlled manually by a simple twist of the hand-wheel or automatically by a remote control or combustion control system. It is built to give most economical, efficient service for any type of pulverized coal, gas, or oil-burning register as well as for stoker-fired and industrial type furnaces.

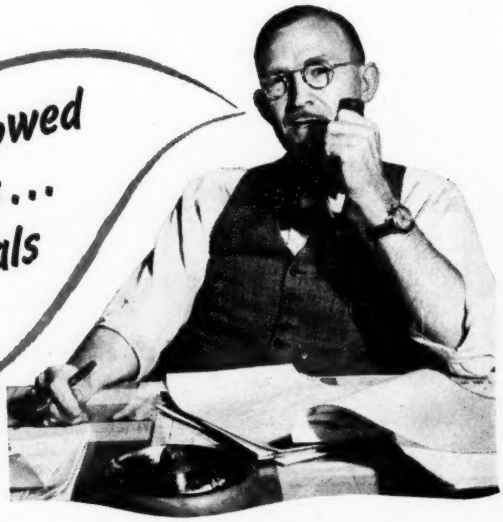
**● WRITE TODAY FOR FULL INFORMATION**

EC-477

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

## Chief Research Engineer Reports on Valve Trim Materials

***"S" Monel consistently showed better anti-galling properties... than any of the other metals we have tested...***



*Albert D. Eplett*

These are the words of Albert D. Eplett, chief research engineer of MANNING, MAXWELL & MOORE, INC., Bridgeport, Conn.

***As a result of controlled laboratory tests made under his direction over a period of years, "S" Monel* is now standard material for guide sections in four types of Consolidated Safety Valves.***

Here Mr. Eplett tells you about one of the actual tests:

"We carried out our anti-galling tests," he says, "by building a small valve identical to the larger ones ordinarily used. We devised a cam-operated mechanism that would give us lifting characteristics similar to those that occur with steam. Superheated air was carried in through the nozzle and up over the disc and guide portions, where we located thermocouples. When galling occurred, a cut-out device shut off the operating mechanism.

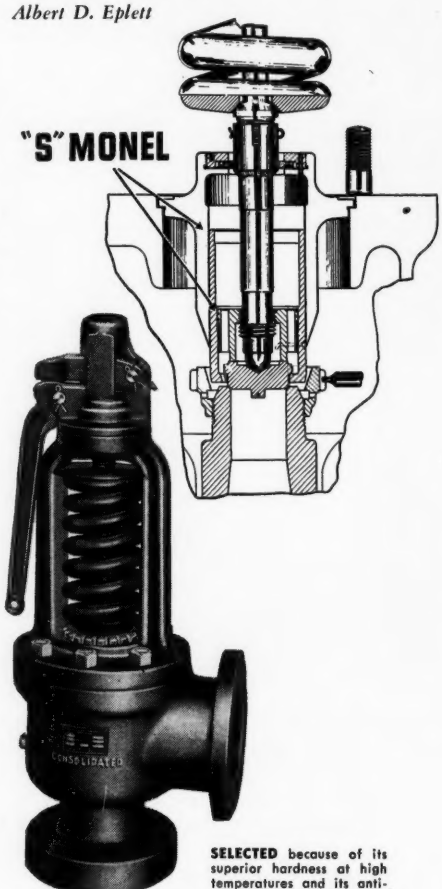
"By this method, we have tested a great number of valve trim materials, including the so-called super alloys. ***And we discovered that "S" Monel consistently showed better anti-galling properties in combinations with other metals and against itself than any of the other metals we have tested*** – excluding, of course, hard facing alloys, which are not as economical to use."

"S" Monel, in addition to its non-galling characteristics, has the well-known properties and advantages of *all* INCO Nickel Alloys. ***It is strong . . . tough . . . fatigue resistant . . . corrosion resistant.*** It simplifies fabrication and offers economies in valve trim for high temperature service; it is an outstandingly efficient material for heat-treated engine castings, hot air scoops, fuel line fittings, pump liners, fuel and oil tank flanges, wing hooks, etc.

### DO THIS – NOW

Get more information about extra-hard heat-resistant "S" Monel and other specialized valve materials. Write to R. F. Johnson, c/o The International Nickel Company, and ask him to send you INCO's valuable booklet, ***Trimming Valve Costs with Lasting Trim.*** It tells you how to make valves last longer, whether they handle live steam, hot chemicals, compressed air or corrosive cooling water. Send today for your free copy. A post card will do.

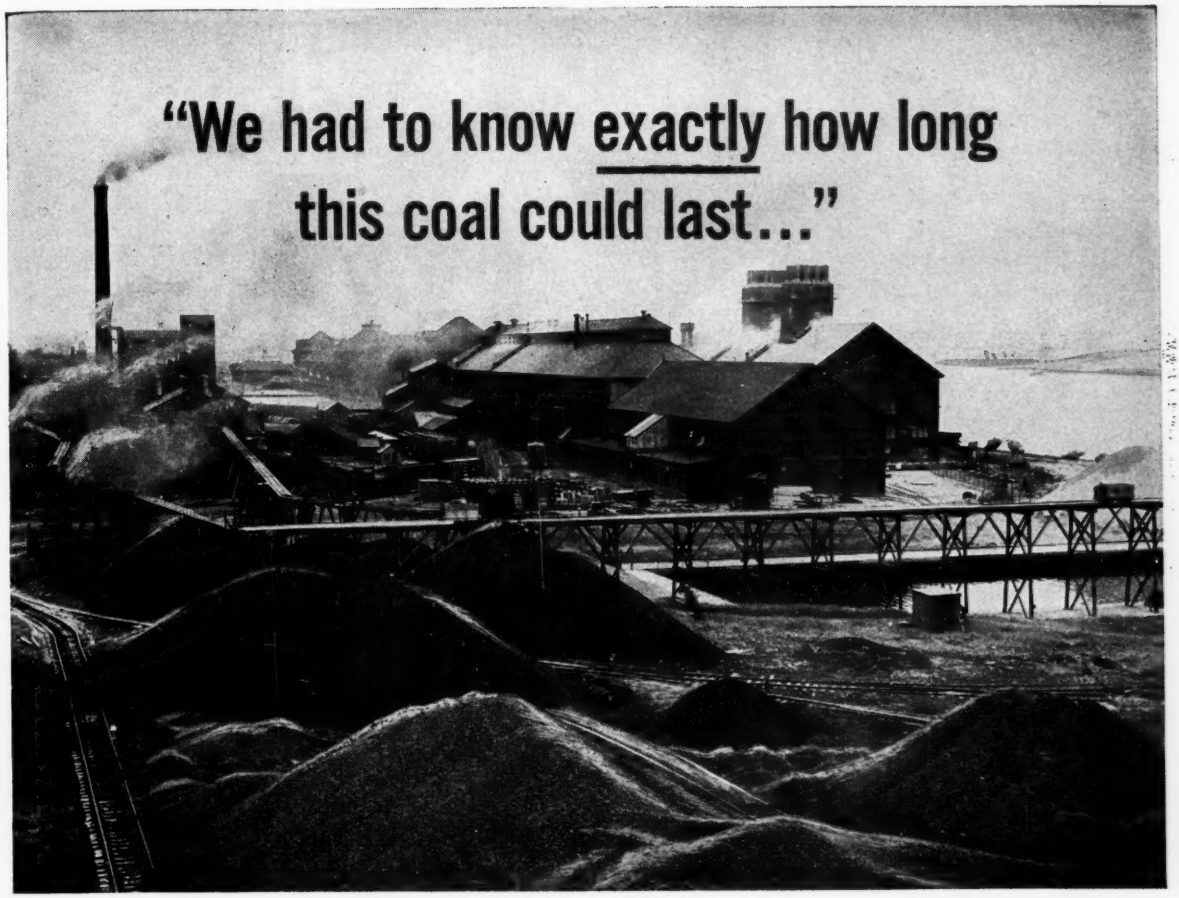
*Reg. U. S. Pat. Off.



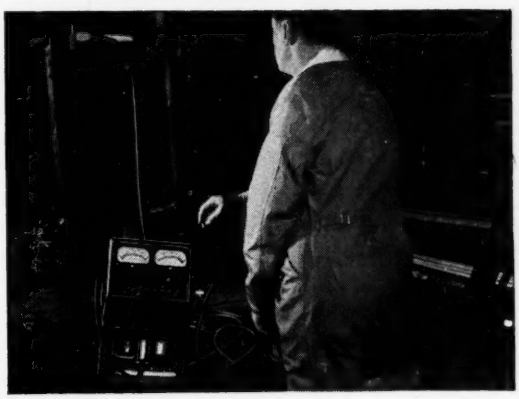

**SELECTED** because of its superior hardness at high temperatures and its anti-galling properties, "S" Monel is now standard material for guiding sections (arrows) in this Manning, Maxwell & Moore Consolidated Safety Valve. Used in the hardened state, the "S" Monel parts cast at Inco's foundry are given a ground finish with an emery cloth polish prior to assembly.

**THE INTERNATIONAL NICKEL COMPANY, INC.**
***67 Wall Street, New York 5, N. Y.***

EMBLEM OF SERVICE
NICKEL INCO ALLOYS
MONEL* • "K"* MONEL • "S"* MONEL • "R"* MONEL • "KR"* MONEL
INCONEL* • NICKEL • "L"* NICKEL • PERMANICKEL* • DURANICKEL* • INCONEL "X"*
*Reg. U.S. Pat. Off.




# "THE REMARKABLE CITIES SERVICE INDUSTRIAL HEAT PROVER TOLD US"



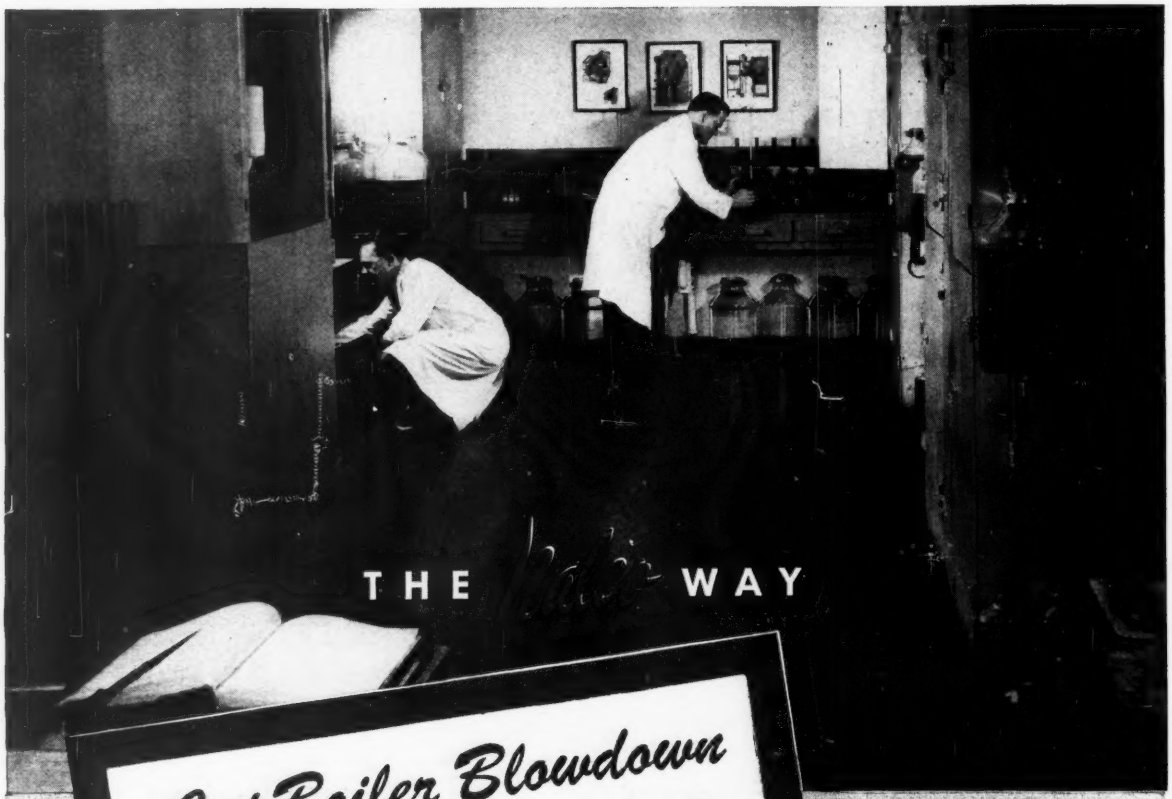
**THE INDUSTRIAL HEAT PROVER** is an exhaust gas analyzer, designed for use on industrial furnaces regardless of size or type. It is provided with two scales; one shows the percent of oxygen present above the theoretical amount necessary for complete combustion, the other the amount of unburned fuel going into the atmosphere.

"GUESS WORK on coal consumption was a critical problem with us. We had to know, ton-for-ton, exactly how much power we could generate efficiently. When the Cities Service representative demonstrated the Heat Prover, the results were astonishing. This remarkable instrument told us quickly, accurately and continuously how much fuel we needed for maximum efficiency... how much was wasted by needlessly heating excess air... and how we could correct this loss."

If you feel your operation could profit from scientific control of combustion why not get in touch with a Cities Service representative today. Ask for a free demonstration of the Cities Service Industrial Heat Prover.

*Free*— A new fact-filled booklet entitled "Combustion Control for Industry." Write Cities Service Oil Company, Room 481M, Sixty Wall Tower, New York 5, N. Y.

**CITIES SERVICE**




# Cut Boiler Blowdown and Stop Carryover

without expensive equipment

HIGHER, safely-carried dissolved solids concentrations can save you fuel and water . . *do* save substantial sums in hundreds of plants using Nalco Antifoam compounds with the complete Nalco System of Water Treatment.

Steam purity is another important factor in economical, efficient plant operation with the Nalco System. Clean steam means clean equipment and piping that stays on line—saves on maintenance and cuts down-time.

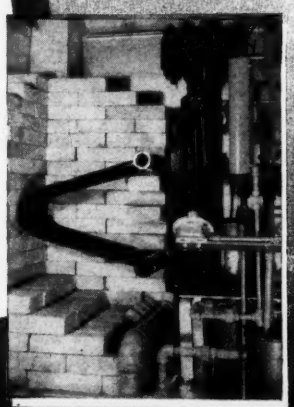
Details on the Nalco System for your plant—whether your boilers operate at 20 or 2000 p.s.i.—are available promptly on request. Nalco Bulletin 41 may also be of help to you: it is a thorough discussion on determination of steam quality, and the installation of sampling and recording devices. Write for Bulletin 41 today.

**NATIONAL ALUMINATE CORPORATION**
**6224 West 66th Place • Chicago 38, Illinois**

*Canadian inquiries should be addressed to Alchem, Limited, Burlington, Ontario, Canada*

**Above — The Nalco Way to water treatment results is unending research and development of continuously better methods and chemicals . . . Here, research goes forward in the Nalco Laboratories' Experimental Boiler Room (partial view).**

**Below — One of the Nalco 1500 p.s.i., gas-fired miniature test boilers, used in antifoam research. Photo made before completion of furnace refractory and insulation.**



Nalco

. . . Serving Industry the

# HELPFUL BULLETINS

**Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail**

## ELECTRICAL

**101** **High Amp Cable**—Compiled to aid those concerned with low voltage wiring, 24-pp Catalog 5476 presents the practical advantages of this cable, at the time of installation and afterward. Describes and illustrates its asbestos insulation and gives reasons why use of this cable cuts wiring costs. Engineering data includes conduit size tables, calculator, graphs for power wiring and information on figuring cable requirements. Rockbestos Products Corp.

**102** **Magnetic Relays**—Twelve-pp Catalog D-20A fully illustrates and describes seven standard types of relays for industrial and general purpose control applications. Complete technical data on relay ratings, dimensions, coil specifications and applications are included. Relays listed are available from stock. Ward Leonard Electric Co.

**103** **Full Voltage Starter**—An oil-immersed, full-voltage, wall mounted starter for control of squirrel cage motors and the primary of wound rotor motors of 350 hp or less at 2300 v is described in Bulletin 14B7274, 4 pp. Illustrations include photos of complete assembly, magnet armature, contacts, auxiliary switch and other parts, as well as wiring and dimensional diagrams. Allis-Chalmers Mfg. Co.

**104** **Induction Motors**—Large, high-speed motors ranging up to 3000 hp in squirrel-cage and slip-ring types are described and illustrated by photos in Bulletin 501, 4 pp. Construction features are explained and applications discussed. The Ideal Electric & Mfg. Co.

**105** **Voltage Control**—Four-pp Form 424-K is devoted to company's continuously adjustable transformers for controlling a-c operated equipment. Presents advantages and general specifications of the lie. Includes photos of available types, detailed specifications, dimensions, ratings and prices. General Radio Co.

**106** **Arc-Welding Supplies**—Twenty-pp Publication GEC-253A contains descriptions, specifications and prices of more than 150 arc-welding accessories. Includes information on electrode holders, helmets and goggles, tungsten electrodes, protective aids and clothing, electrode carriers, cable connectors, ground clamps, brushes, cleaning tools, fillet weld gage and many other accessories. General Electric Co.

**107** **Generator Installations** — Titled, "Your Guide to Profitable Installations of Modern Generators," 8-pp Bulletin 2200-PRD-196 tells in non-technical language the points to look for when ordering generators. Manufacturer's special construction features and their meaning in terms of continuous, economical operation are pointed out and illustrated. Many recent installations of large slow-speed engine-type generators are shown. Electric Machinery Mfg. Co.

## PIPING AND ACCESSORIES

**108** **Industrial Piping**—This 4-pp bulletin gives at-a-glance information on company's piping, showing available materials and the chemical products they handle. Covers wood stave, wood lined, Saran rubber lined pipe, and stainless steel and monel tubing. Illustrates and describes wood piping in detail, discussing its advantages and applications. Michigan Pipe Co.

**109** **Pipe Line Filters**—Eight-pp Bulletin B-1A deals with pressure and vacuum type filters for use on pipe lines handling air and other gases. Illustrated with photos and cutaway drawings, bulletin covers filters' double-action principle of operation, discusses their efficiency, accessibility and other advantages. Includes sizes, typical layouts. Dollinger Corp.

**110** **By-Pass Unit**—A unit described as an economical means of by-passing valves and traps is presented in 4-pp Bulletin 254-1. The by-pass, illustrated by photo and sectional drawing, is discussed as to operation and construction and its sizes and prices given. Covers both bronze and semi-steel types for service at temperatures up to 400 F and cast steel for service up to 750 F. Belfield Valve Div., Minneapolis-Honeywell Regulator Co.

## INSTRUMENTS AND CONTROLS

**111** **Combustibles Recorder**—Design improvements and new applications for company's combustibles recorder are featured in 16-pp Bulletin 150-A. Drawings and photographs explain how this electronic type instrument operates on the catalytic combustion principle. Typical applications to boiler furnaces, atmosphere producers, rotary kilns, industrial furnaces and chemical processes are illustrated. Both air and electrically-operated control of combustibles are pictured and described. Also described is the recorder's a-c measuring circuit. Bailey Meter Co.

**112** **Electric Tachometer**—Bulletin 492, 4 pp, introduces company's portable electric tachometer and cutmeter for precision service. Gives specifications, and discusses advantages and design features of magneto, indicator and indicating scales. Photos show instrument and carrying case. The Electric Tachometer Corp.

**113** **Industrial Thermometers**—Complete installational data on liquid-in-glass industrial thermometers is presented in easy-to-use tabular and sectionalized form in 16-pp Bulletin E. Graphic pages illustrate basic models, sizes, forms and attachments and provide application information of help in selecting proper thermometer. This bulletin is described as an all-in-one complete reference guide. Precision Thermometer & Instrument Co.

**114** **Combustion Control**—Technical Bulletin 103, 8 pp, contains an exposition of the nature of haze and its use as a combustion index and a description of devices ranging from the simplest auxiliary controls for addition to present systems to complete electric-eye installations. The information includes a discussion of methods of control for all hydro-carbon fuels, including oil, gas and bituminous coal of varying analyses, burned separately or together. Contains many installation photos. General Power Plant Corp.

**115** **Flow Meters**—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, the bulletin explains how meter operates and discusses its advantages. Gives typical specifications and includes correction factor charts and capacity tables. Builders-Providence, Inc.

**116** **Metal Defect Detector**—Company's "Reflectoscope," an ultrasonic instrument for locating defects in metals and other materials is featured in 4-pp Bulletin 50-105. Illustrated with photos of

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searching unit and some of its applications, it explains instrument's principle of operation. Includes specifications, discussion of general applications. Sperry Products, Inc.

## COAL HANDLING

**117** **Coal Handling Equipment** — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated with sketches and photos of actual installations, it covers concrete and tile silos, cylindrical steel tanks, and suspended steel bunkers with gravity discharge bucket elevators and pivoted bucket carriers. Also describes and illustrates a skip hoist and other auxiliary equipment. Gifford-Wood Co.

**118** **Coal Storage** — Eight-pp Form M5 809A-1046 covers use of manufacturer's crawler tractor in the storing and handling of coal. Explains how its use permits fireproof storage of coal, the economy afforded by both original cost and operating cost, and the flexibility of the tractor. Describes and illustrates a modern coal handling installation. Also discusses and pictures coal storing and reclaiming operations by the tractor in combination with scrapers and bulldozers. Allis-Chalmers Mfg. Co.

**119** **Bulk Weighing Scale**—Construction details, specifications and dimensions for an automatic optional feed weighing unit for handling coal, coke, cement, fly ash and similar bulk materials are presented in 4-pp Bulletin 1449. Weighing assembly and process control are illustrated by photos. Richardson Scale Co.

## VALVES

**120** **Air Release Valves** — Bulletin 1200, 8 pp, devoted to company's air release valves, includes a discussion on air in water pipe lines and the essential requirements for valves of this type. Illustrates methods of installation and explains valves' construction and operation. Covers types for standard, high pressure and special services. Contains photos and diagrams of the valves and a large cross-section showing materials of construction. Simplex Valve and Meter Co.

**121** **Gate Valves**—Four-pp Bulletin AD 1803 presents company's fluid-motor gate valves and an explanation of how they help to increase plant efficiency and promote lower operating costs. Text tells how the fluid motor works and is illustrated by photos and sectional drawings. Available types and sizes listed. Crane Co.

**122** **Face-to-Face Valves** — Twelve-pp Catalog 18 introduces a line of 50-lb narrow face-to-face valves designed especially for rugged hydraulic service. The various types of valves and controls are described and illustrated. Also presented are the stuffing boxes, which include plain, lubricated, lubricated with purge connections, and rotary seal types. Advantages of the valves, a description of the rubber seat, special metals, and dimensions and weights, provide essential engineering information. R. S. Products Corp.

**123** **Gate Valves** — Specifications, sizes, and dimensions for company's bronze gate valves of heavy duty construction for use on steam, water, oil, or gas lines are provided in pocket-size Circular 102. Brief text discusses maintenance, installation and operation of these valves. Photos illustrate screwed and bolted bonnet types, large cutaway drawing shows design. The Kennedy Valve Mfg. Co.

## CENTRIFUGAL PUMPS, BLOWERS

**124** **Centrifugal Pump Manual**—Bulletin 812-A, 12 pp, is a revised instruction booklet on the installation and operation of centrifugal pumps in corrosive service. While dealing specifically with manufacturer's pumps, the information is applicable to all centrifugal pumps. It deals with location and foundations for pumps, correct alignment, priming, piping arrangements, adjustment of impellers, and how to overcome common troubles. Friction data, formulas for figuring capacity, head and horsepower, and conversion data are included, as are many photos and drawings. Intended for frequent reference, this book is printed on varnished and "smudgeproof" paper. The Duriron Co., Inc.

**125** **Centrifugal Blowers**—Bulletin 120-B-14 is company's 24-pp revised booklet on blowers and exhausters. Discusses centrifugal advantages and the operating characteristics of manufacturer's units. Design and construction features of single stage and multi-stage units are explained and illustrated with photos, cross-sections, diagrams, curves and exploded views. Regulation is also discussed and many photos of typical installations are included. Roots-Connersville Blower Corp.

**126** **Blowers and Exhausters** — Bulletin B-5-A, 4 pp, covers a line of centrifugal type blowers and exhausters for handling air and gases of various densities, temperatures and chemical composition, for such applications as agitation, aeration, combustion, cooling and ventilation, gas manufacture, conveying. Illustrates and describes heavy cast iron and high volume steel construction models, providing necessary data on specifications, capacities and sizes. Allen Bilmyre Div., Lamson Corp.

## BOILERS AND TURBINES

**127** **Boilers and Auxiliaries** — Manufacturer's water tube boilers and steam generating equipment is illustrated by photos and sectional drawings and discussed as to design and applications in this 24-pp catalog. Covers boilers of the bent tube and straight tube types, superheaters, water cooled furnaces, economizers, preheaters and process equipment. Edge Moor Iron Works, Inc.

**128** **Multi-Stage Turbines**—Catalog 4200, 24-pp, includes a discussion of the economics of by-product power, along with diagrammatic sketches that show the utilization of heat for various typical plant operating conditions. Emphasizes the flexibility of turbines' drive and shows basic types of company's turbines for different operating conditions and applications up to 20,000 hp. Many photos are devoted to design features and a series of cutaway diagrams show governing and control systems. Also included is 2-pp spread on helical gears for applications using geared turbine drive equipment. De Laval Steam Turbine Co.

## HEATING, VENTILATING SYSTEMS

**129** **Turning Vane and Volume Control**—Bulletin 30, 4 pp, describes construction, installation and operation of a turning vane and volume control device for balancing heating, ventilating, and air conditioning systems. Amply illustrated with photos, diagrams and tables, it discusses how the unit eliminates one-sided air flow and provides volume control previously considered unobtainable with ceiling air diffusers. Also points out that fraction loss is greatly reduced with this unit. Dimensions and installation data for seven sizes ranging from 12.5 to 30 in. dia are given. Smoke test photos show how air stream is accurately controlled by adjusting regulating rod. Anemostat Corp. of America.

**130** **Duct Insulations** — Twelve-pp Publication IN6.A1 contains design data for the application of manufacturer's duct insulating materials. Their properties are described and a 2-pp illustrated section provides a detailed description of several methods of application. Covers use of coated duct insulation, flexible insulation for exterior use and finishing of duct surfaces. Generously illustrated with two-color photos and sketches. Owens-Corning Fiberglas Corp.

## WATER CONDITIONING

**131** **Water Conditioning** — Bulletin WC-100, 8 pp, concisely outlines company's water conditioning products, services and background. Explains its scope of activities in the boiler plant, process work and general industrial fields and is illustrated by some of company's large installations of hot-process and zeolite softeners, demineralizers, clarifiers and filters. Graver Water Conditioning Co.

**132** **Deaerating Equipment**—Publication 3005, 35 pp, is a revision of company's catalog on deaerators. Combines recent information on the importance of

*(Continued on page 111)*

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For maximum production . . . top efficiency . . . lowest operating cost, give your machines the finest in lubricants—give them Tycol oils and greases.

Tycol lubricants are made to meet every lubrication need of industry—from roll neck greases for steel mills to spindle oils for textile plants.

Each Tycol lubricant is subjected to rigid tests during manufacture. This control assures the required lubrication characteristics—*COLOR, penetration, viscosity, to name a few—for maximum performance of that particular product. At every step from selection of crudes to blending of the finished product, Tycol lubricants provide maximum lubricating efficiency which means greater economy, longer life for every type of equipment.

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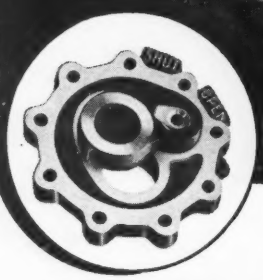
# STOP WORRYING ABOUT FIRE!

Closing Type
Fig. 4831 BC

Opening Type
Fig. 4721 BC




## *Get* EVERLASTING VALVE *protection*

Here are two valves you can *depend on* for protection of your property when fire threatens. Weight-operated with pendulum stop — controlled thermostatically, electrically, or manually — they provide instant action for instant protection.

Available in both opening and closing types, these Everlasting Valves are suited for Dip Tank Discharge, Fuel Oil Shut-off, Foam and other Fire Protection Systems.

For emergency shut-off of inflammable liquids, or to concentrate water or steam in fire mains, specify the *Closing Type* Everlasting Valve (Fig. 4831 BC).

For diversion of water to sprinkler deluge or water curtain systems, or to divert inflammable liquids to a safe point, specify the *Opening Type* Everlasting Valve (Fig. 4721 BC).

Positive in action, these Everlasting Valves provide instant, unfailing protection when released. They will not stick because their materials will not corrode in use. They will not bind because there is no external stuffing box. They will not wedge because the disc action parallels the valve seat. Straight-through design permits a full unimpeded flow.

What's more, no pendulum swing-stop is necessary. At bottom of its swing, the weighted pendulum is disengaged from the valve mechanism . . . there's no possibility of valve fracture due to impact.

For all details on these Everlasting fire protection valves, send for our Bulletin E-52 C — *today!*

***Manufactured by***

**EVERLASTING VALVE COMPANY**

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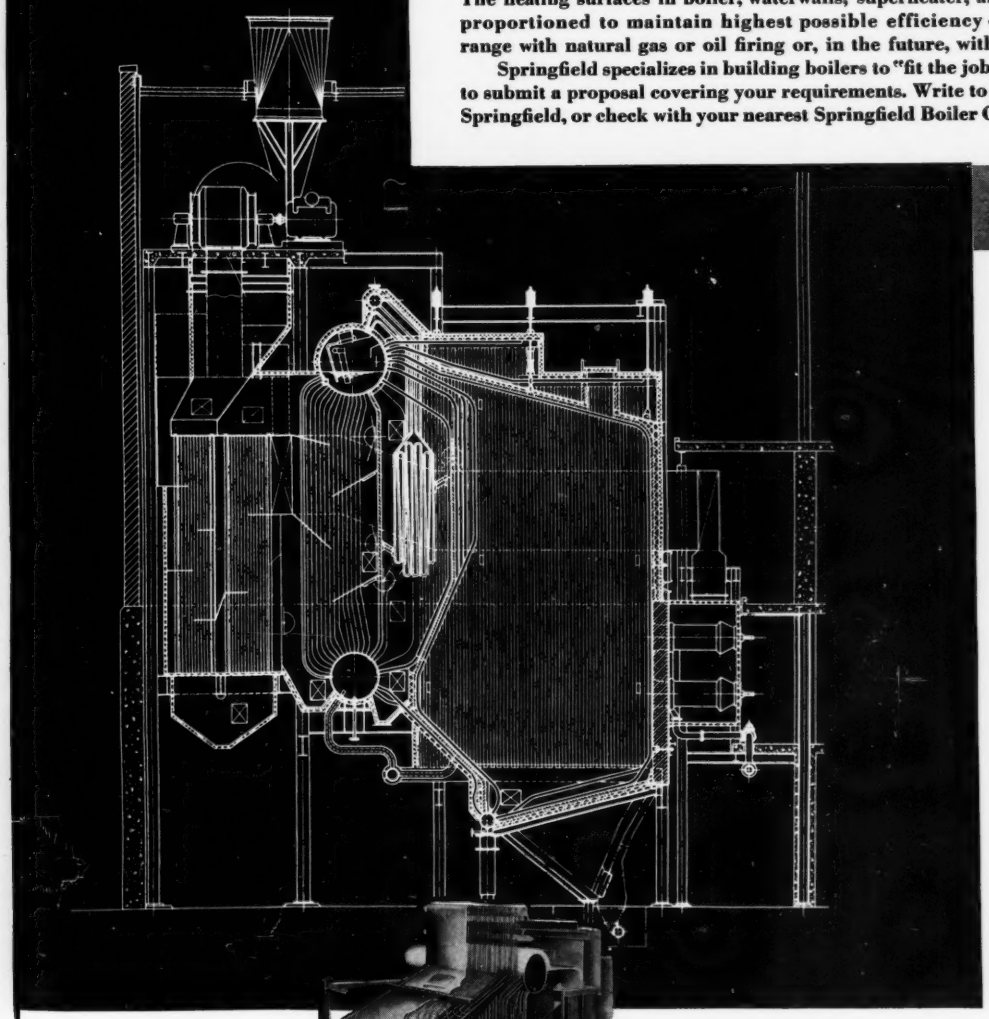
**EVERLASTING VALVES** *GIVE "EVERLASTING" SERVICE*

# COMPLETE STEAM GENERATOR

**This new Springfield steam generator for municipal service in Colorado Springs, Colorado, is a typical example of the modern, economical units Springfield is building for power, process, and heating plant service in locations extending from the eastern seaboard to the far west. It is designed to handle loads ranging from 50,000 lbs. to 150,000 lbs. of steam per hour at 410 psig operating pressure with 750° F. steam temperature at superheater outlet. The heating surfaces in boiler, waterwalls, superheater, and air heater are proportioned to maintain highest possible efficiency over a wide load range with natural gas or oil firing or, in the future, with pulverized coal.**

**Springfield specializes in building boilers to "fit the job". We will be glad to submit a proposal covering your requirements. Write to our main office in Springfield, or check with your nearest Springfield Boiler Co. representative.**



*Location:*
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*Consulting Engineers:*
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## SPRINGFIELD PRODUCTS

BENT TUBE STEAM GENERATORS—Modern designs for capacities from 10,000 lbs. up.
STRAIGHT TUBE BOILERS—Specially designed for capacities from 5,000 to 450,000 lbs. per hour and higher.
STANDARDIZED TYPE MC BOILERS—Standardized for quicker delivery and lower cost. Sizes 7,500 to 17,800 lbs. per hour.
WATER COOLED FURNACES—Heavy duty water walls. Exclusive center water wall construction for larger units.
SUPERHEATERS — AIR HEATERS — ECONOMIZERS — Individually designed to meet requirements.

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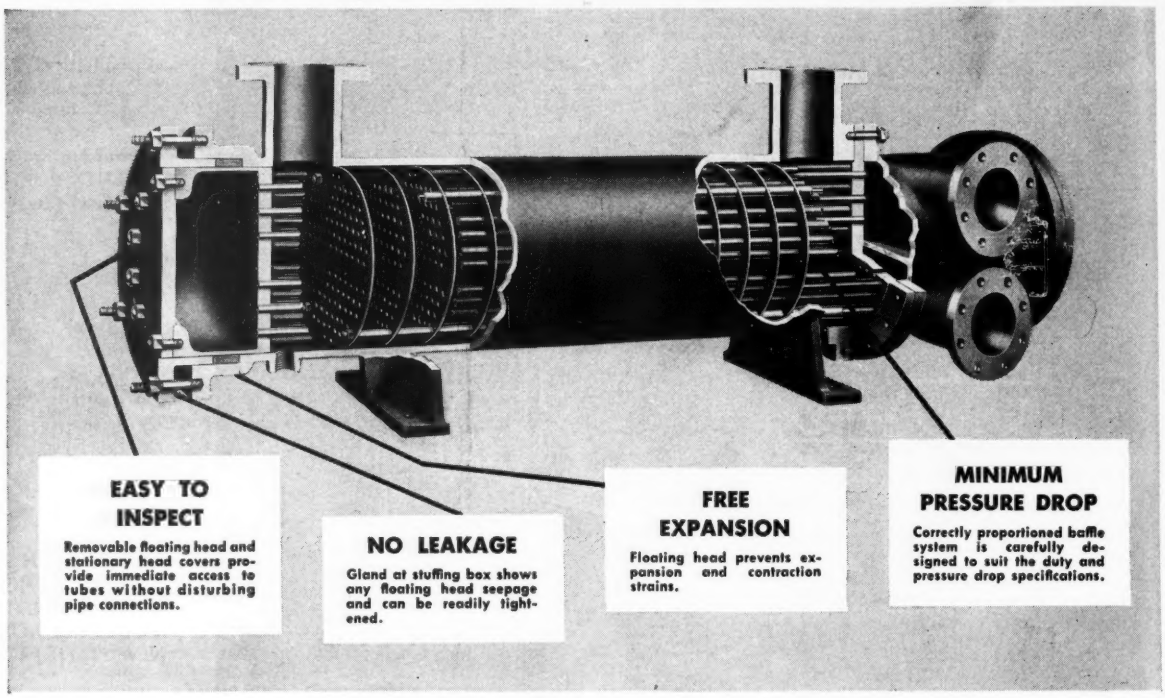
# G-R MULTIWHIRL COOLER

## *has multi-advantages for cooling...*

**Lubricating Oil**
**Transformer Oil**
**Diesel Jacket Water**
**Circulating Water**
**Waste Liquors**


EASY TO INSPECT
Removable floating head and stationary head covers provide immediate access to tubes without disturbing pipe connections.
NO LEAKAGE
Gland at stuffing box shows any floating head seepage and can be readily tightened.
FREE EXPANSION
Floating head prevents expansion and contraction strains.
MINIMUM PRESSURE DROP
Correctly proportioned baffle system is carefully designed to suit the duty and pressure drop specifications.

YEAR AFTER YEAR, you'll benefit from these important design features of the G-R Multiwhirl Cooler. These sturdily-built units stay on the job, providing effective heat transfer with minimum maintenance. Thousands of installations have already proved the multi-advantages of the G-R Multiwhirl Cooler.

If your plant operations require the cooling of liquids, be sure to get the "inside story" on the G-R Multiwhirl Cooler. Bulletin 710 fully describes these units. Write for your copy today.

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RIGHT AROUND THE CORNER

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# RIC-WIL

# PREFABRICATED PIPE UNITS

The most recent extension of the Ohio Edison Company's Central Heating System in Akron, Ohio was speeded to completion by the installation of these "around-the-corner" Ric-wiL Pre-fabricated, Pre-insulated Pipe Units.

With 14″ pipe and insulation housed in corrugated ingot iron conduit, factory prefabricated to the above configuration, these units are among the many Ric-wiL sub-assemblies forming the 975 foot artery which supplies steam from Ohio Edison's Beech St. Plant to various distribution centers.

*For more complete detailed information on Ric-wiL Insulated Piping Systems write: The Ric-wiL Company, Cleveland, Ohio, Department 7U.*

*Specified* Ric-wiL Units exemplify Ric-wiL's scientific approach to piping problems with resultant efficiency and economy. Ric-wiL Units are accurately designed and shaped to permit free flexure of entire piping systems in all planes with a minimum lineal footage of piping.

Prefabrication is under rigid engineering control with exact adherence to specifications, assuring simplified, low-cost installation and dependable, uninterrupted service with long life and outstanding durability.

**RIC-WIL**

INSULATED PIPING SYSTEMS

THE RIC-WIL COMPANY • CLEVELAND, OHIO

REPRESENTATIVES IN PRINCIPAL CITIES

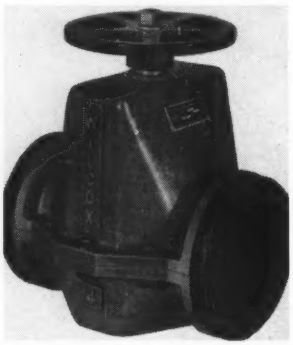
# NEW EQUIPMENT NEWS

**WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.**

## 1—RUBBER PINCH VALVE

**For handling corrosive liquids, semi-solids and granular material**

Described as non-corrosive and non-clogging, this valve is recommended for use in pipe lines handling pulp and paper stock, acids and salt solutions, lime slurry, wet and dry ash, sand, coal and other abrasive and corrosive slurries and liquids difficult to handle. It is not recommended for use in lines transporting material damaging to rubber, or where temperatures are high.



It is comprised of a rubber tube, metal pinching mechanism and housing. The straight round tube with internal flanges is natural rubber reinforced with woven duck plies.

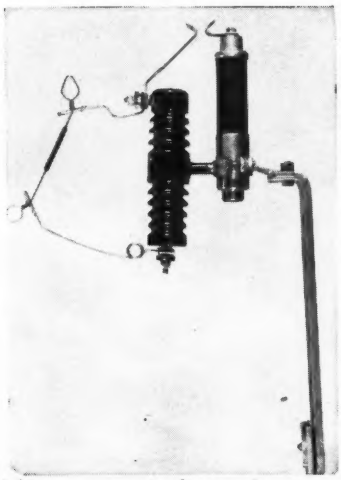
Valve closes easily and positively because rubber is designed to compress around any coarse particles. Exposure to freezing weather doesn't lessen its efficiency, it is said. Other advantages claimed are excellent control, leak-proof shutoffs, and long service under severe conditions. Ray Wilcox Co.

## 2—ARRESTER AND CUTOUT

**Is unit-combination designed for use on rural circuits**

The Unit-combination Arrester and Cutout, is said to represent a 20 per cent saving over single item purchases of its components. The unit combines basic design features of company's 9 kv hi-stroke arrester and the 7.8 kv, 50-amp flip-open cutout and is intended to provide low-cost protection of conventional distribution transformers on rural lines rated 7200/12470 and 7620/13200-v grounded Y. It is available with either the EEI-NEMA standard mounting bracket for crossarm or direct-to-pole mounting, or an optional bracket for use with distribution transformers.

Advantages claimed for the arrester include: low spark-over voltage, high discharge current capacity, exclusive built-in reserve of gas-evolving material to compensate for erosion.



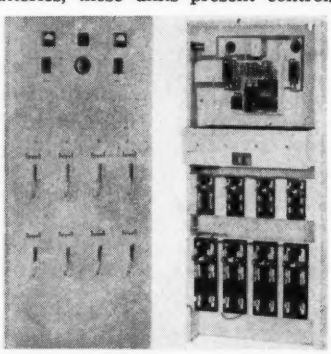
The combination is designed to provide close coupling between the arrester element and the cutout insulator—to combine the advantages of small physical size and virtual freedom from short circuits caused by birds, yet maintain liberal electrical clearances. Transformer and Allied Products Divs., General Electric Co.

## 3—BATTERY CHARGERS

**Automatic selenium rectifier type with magnetic amplifier**

These chargers are designed for locations where a minimum of maintenance is required; the magnetic amplifier controls used in them have no moving parts. Manufacturer states that the chargers maintain a steady, constant output voltage with ± 1 per cent regulation regardless of line variations or load fluctuations.

Intended for "float and booster" charging of lead-acid and nickel-iron batteries, these units present controls, meters, rectifiers and distribution load centers in one complete panel. Floor standing and wall-mounted, these chargers fit in with existing panels. Circuit breakers or fuses in the a-c input and d-c output offer overload protection. Industrial Electronics & Transformer Co.



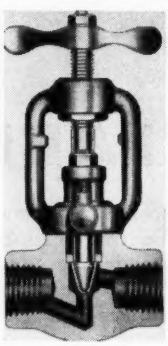
## 4—INSTRUMENT VALVES

**Of strong forged steel are compactly built for power installations**

These forged steel instrument valves, small enough to fit into limited spaces and sturdy enough to withstand pressures as high as 6000 lb, are recommended for installation on control panel boards and other small lines in boiler houses and central power stations.

Of carbon steel, 13 per cent chromium stainless steel, or 18-8 stainless steel, these valves come in globe or angle design in ¼ in., ⅜ in., and ½ in. sizes.

The valves are described as ideal for providing close regulation on orifice meters, regulator lines, gage lines, instrument panels, pumps, by-pass lines, and other small lines. It is pointed out that the stainless steel valves are resistant to many corrosive influences. Edward Valves, Inc.



Valve

Guillotine

## 5—HYDRAULIC GUILLOTINE

**Is portable hand tool for cutting wire rope and steel rod**

This tool is described as affording 22 t of cutting power and being capable of cutting wire rope up to 1¼ in. and mild steel rod up to ¾ in. It can also be obtained with special center-cut blades for rod only, which will cut ¾ in. reinforcing and 1 in. mild steel. And it can be adapted for crimping, swedging and bending operations on large diameter material.

Guillotine's heavy-duty design features special forgings and high tensile steel castings, but it weighs only 40 lb.

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# Help yourself to better piping

## . . . with <u>one order</u> to CRANE

That's all it takes to get the valves, fittings, pipe and accessories needed for any system. Take this **Circulating, Cooling and Service Water Piping,** for example. Every item shown is in the broad Crane line—the **One Source of Supply** complete enough to simplify every piping procedure, from design to erection to maintenance work.

One order to Crane gives you more dependable service, too. Your local Crane Branch or Wholesaler is well-stocked to meet normal piping needs, and has direct access to large factory stocks. **One Responsibility** for materials assures better installations, avoids needless delays. **High Quality** in every item—and that means Crane Quality—helps you get dependable performance from every part of your piping system.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
*Branches and Wholesalers Serving All Industrial Areas*

**ONE** SOURCE OF SUPPLY
RESPONSIBILITY
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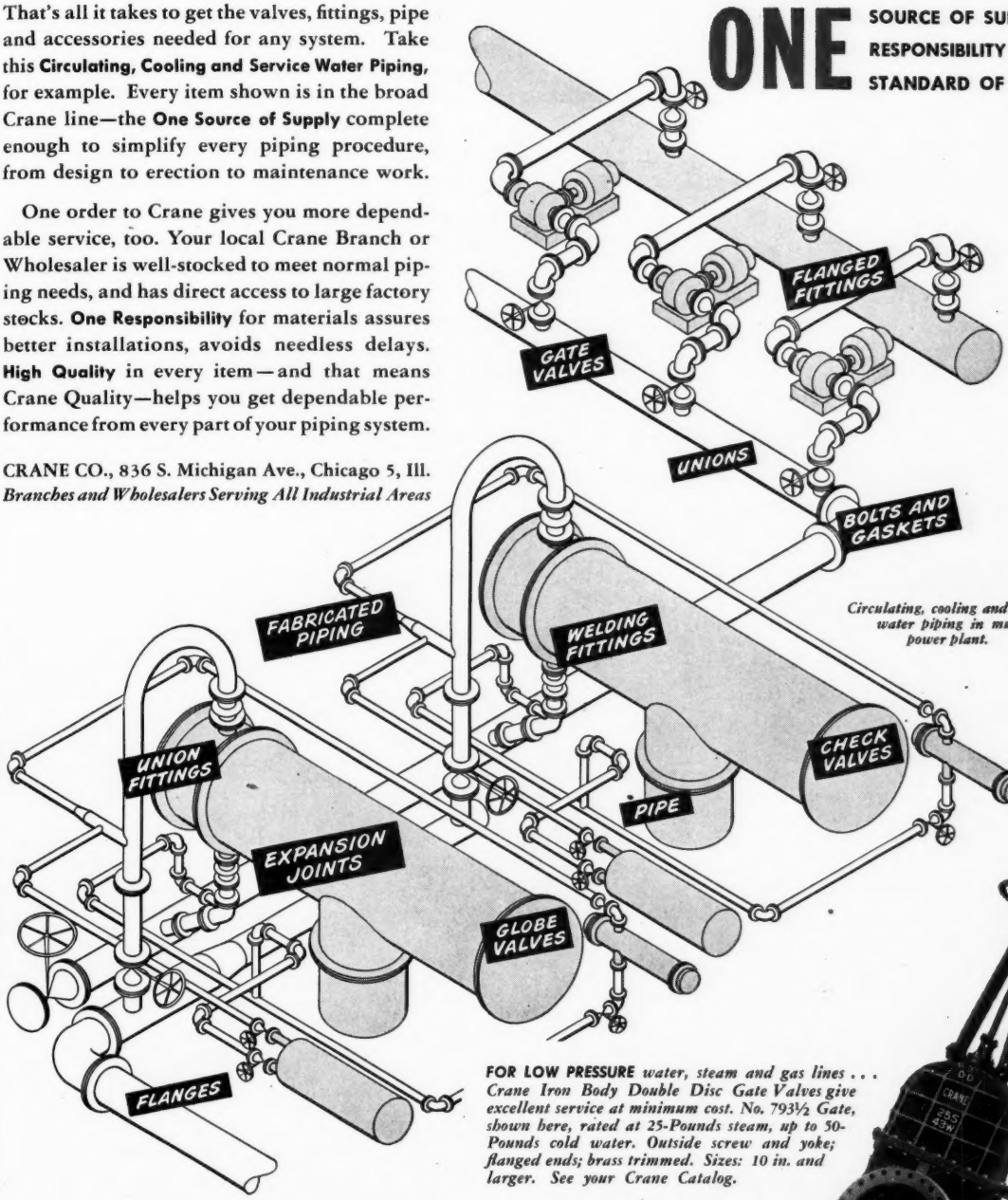



*Circulating, cooling and service water piping in municipal power plant.*

**FOR LOW PRESSURE** *water, steam and gas lines . . . Crane Iron Body Double Disc Gate Valves give excellent service at minimum cost. No. 793½ Gate, shown here, rated at 25-Pounds steam, up to 50-Pounds cold water. Outside screw and yoke; flanged ends; brass trimmed. Sizes: 10 in. and larger. See your Crane Catalog.*

**EVERYTHING FROM . . .**

**VALVES • FITTINGS**
**PIPE • PLUMBING**
**AND HEATING**

# CRANE

**FOR EVERY PIPING SYSTEM**

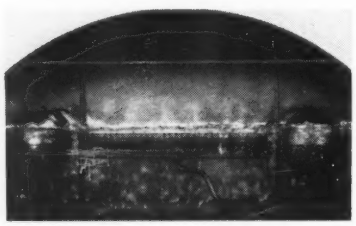
**Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.**

Operated by hand pumping, the cutter uses operator's weight, not strength, to make the cut, it is stated. Oil seals used in the unit are intended to prevent leakage at both maximum pressure and no pressure. Other design features are said to provide positive blade retraction when release valve is opened after cutting and to include a safety relief valve for preventing damage by overloading. Manco Mfg. Co.

## 6—CONTROL DEVICE

**For automatic regulation of surface blowdown in boilers**

The Floating Skimmer is intended for use in boilers to achieve accurate, automatic blowdown of suspended and dissolved solids from a point at or near water surface. Of stainless steel, it consists of a shallow adjustable trough 20 in. long by 5 in. wide by 2 in. deep, suspended between two 6½ in. dia spherical floats, and having a screen mounted over the top. The floats are guaranteed to withstand up to 1400 psi. Drainage from trough is through a flexible stainless steel hose.



When installed, the skimmer floats at or near water surface, held in place by guide rods fastened to top of boiler shell. Skimmer is designed to provide blowdown at a pre-determined point, regardless of fluctuation in water level. It is adjustable, so trough may be submerged to proper distance.

The screen mounted over the trough is designed to delay rapid passage steam bubbles and to cause more of them to break there. These bubbles have suspended solids adhering to their outer surface, and when they break on the screen, tend to deposit these solids in the trough. Boiler Specialties Corp.

## 7—TACHOMETER AND CUTMETER

**Is portable electric unit requiring no external power source**

The M1200-F Electric Tachometer and Cutmeter is designed for accuracy of better than ± ½ of 1 per cent of full scale value. This accuracy is said to be maintained at both low and high speeds over entire range of 0 to 5000 fpm surface speed, 0 to 25,000 rpm shaft speed.

Since generating and indicating instruments are separate, steady readings can be obtained even under adverse conditions, it is stated, and a continuous indication is possible so speed variations can be observed. In applications such as measurement of motor speed it is practical to mount indicator

permanently where convenient. The standard connecting cable may be lengthened to 500 ft.

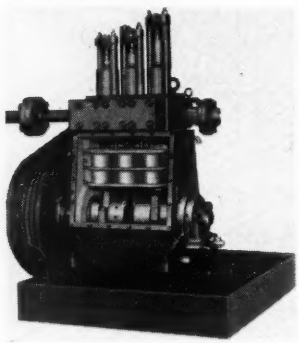
The tachometer is self contained and consists of a rugged precision-built d-c magneto generator that produces a voltage directly proportional to speed being measured, calibrated in conjunction with a laboratory type indicator with four overlapping speed ranges. Electric Tachometer Corp.

## 8—DIRECT FLOW PUMPS

**Are designed for low maintenance and easy accessibility**

This series of 5-in. stroke pumps includes a Triplex model with three cylinders, a Quintuplex with five, a Septuplex with seven, and a Nonuplex with nine. Their horsepower ratings range from 100 to 275. All wearing parts are interchangeable except main bearings.

Said to be an outstanding feature is the fluid-end design, with stuffing boxes at the top of the pump.



Assemblies are easily accessible. Removable stuffing boxes are provided to permit adapting other size plungers to pump, and two sizes of fluid-ends are available for use of plungers ranging from 1¾ to 3½ in. dia.

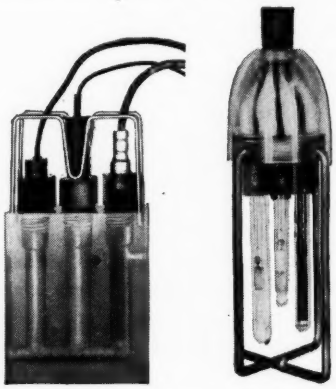
Pumps can be driven by internal combustion or steam engine, by electric motor or steam turbine. Drive connections can be direct or through built-in gearing or by chain, flat or V-belt from extended crankshaft to prime mover, or through integral gear motor or a separate speed reducer. The Aldrich Pump Co.

## 9—ELECTRODE ASSEMBLIES

**For continuous sampling lines and immersion in open tanks, channels**

These two pH electrode assemblies, for use in company's recorders and controllers, feature waterproof design. The sampling line asembly has low capacity said to permit a high flow rate and minimize coating of electrodes by suspended material. Operating pressure can be up to 15 lb. Body of assembly is a block of clear plastic, 4¼ by 1⅜ by 4¾ in. Inlet and outlet connections fit standard ¼ in. pipe.

The immersion unit can be used to a depth of 10 ft, or greater with longer lead wires. It consists of a plastic head, measuring elements, supporting pipe (not supplied) and junction box. The unit has a steel bar guard, but a perforated metal guard is available.

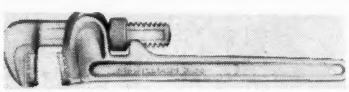


The electrodes and temperature compensating elements, also new, feature lead wires molded into plastic heads to prevent electrical leakage. The glass electrode, calomel electrode and temperature element all screw into place against Neoprene gaskets. Leeds & Northrup Co.

## 10—PIPE WRENCHES

**Made of aluminum alloy are light in weight and long wearing**

Drop forged from high tensile aluminum alloy heat-treated for strength and toughness, these wrenches have strength and service qualities comparable with iron or steel wrenches, manufacturer announces, and they will with-



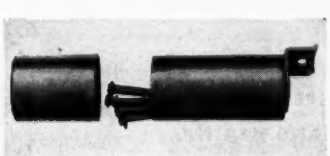
stand abuse and severe usage. Weight has been reduced nearly 50 per cent in these aluminum wrenches, it is pointed out, resulting in greater handling ease.

Replaceable alloy steel jaw inserts are interchangeable. Same insert fits handle or movable jaw. Multiple dovetail design and retaining screw are used for easy assembly, firm anchorage. Inserts are cadmium plated, as is steel adjusting nut. Wrenches have natural satin finish. J. H. Williams & Co.

## 11—STORAGE CONTAINER

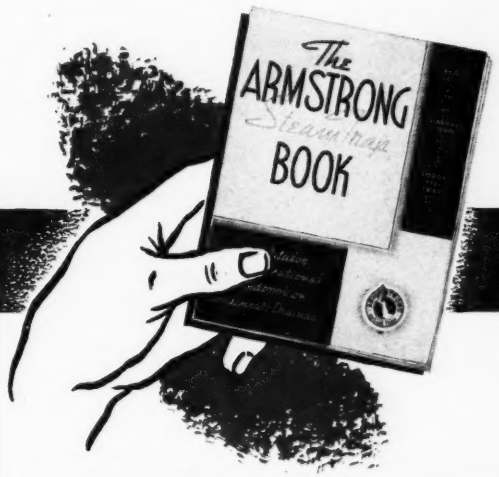
**For spare fuse links, is weatherproof, sturdy, and low priced**

This low-cost container, made of strong, durable aluminum, is equpiped with a galvanized steel bracket for easy pole-mounting. By storing spare fuse links



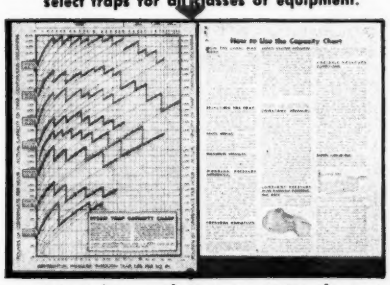
# "You can engineer any trapping job with this book"

YOU CAN'T GO WRONG



Physical data and prices on all sizes and types of Armstrong steam traps.

How to calculate condensate loads and select traps for all classes of equipment.



Actual hot condensate capacity chart for every Armstrong trap, recommended safety factors and specific recommendations for many types of equipment.

THERE is no guess work about steam traps or steam trap selection when you have the 36-page Armstrong Steam Trap Book to work with. You don't waste money on traps that are too big for the job. You don't get inefficient drainage with traps that are too small.

This book explains the design, operation and advantages of Armstrong steam traps, specifies materials used, gives complete dimensional data, includes list prices, actual capacities under working conditions. There are 10 pages of tabular and technical data explaining how to calculate condensate loads and select the correct trap for the job, complete instructions on installation and maintenance. The Steam Trap Book also describes Armstrong traps for draining moisture from compressed air systems, Armstrong steam humidifiers for adding moisture to dry air and Armstrong non-condensable gas purgers for removing air from refrigeration systems.

Anyone is welcome to a copy of this useful guide to good trapping practice. Send for yours today.

**ARMSTRONG MACHINE WORKS**
**810 Maple St., Three Rivers, Mich.**

# ARMSTRONG STEAM TRAPS

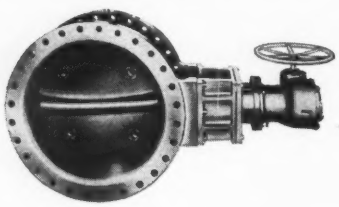
Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.

of the proper size at the cutout location, linemen can restore service more quickly in case of outages. The bright aluminum finish is visible from the ground. Transformer and Allied Products Divs., General Electric Co.

## 12—RUBBER LINED VALVE

**Has 125-lb flanges and renewable one-piece rubber seat for shut-off**

Type No. 709 is a 30-in. 50-lb valve described as air bubble tight at 80 psi and drip tight with water at 100 psi. It may be used efficiently in temperature range from -20 F to 200 F, manufacturer states, adding that the valve shaft moves only with an oscillating



motion and there is no packing difficulty. Special handwheel control has a fully enclosed gear reduction drive. Adaptable to automatic control. Valve is available in smaller or larger sizes, in all materials, and for higher pressures. R. S. Products Corp.

## 13—D-C WELDERS

**With plate-type rectifiers, come in 200, 300, and 400 amp ratings**

These d-c welding machines are rated in accordance with NEMA standards for industrial type, single-operator, arc welders. Major components are a three-phase welding transformer, three-phase adjustable reactor, and plate-type selenium three-phase, full-valve rectifier.

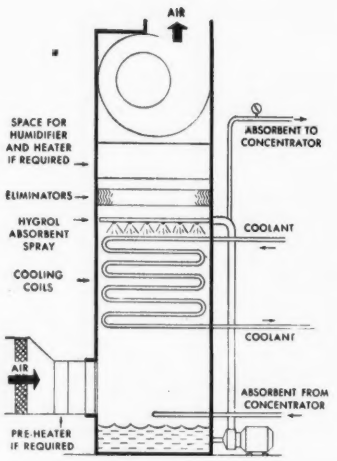
The no-load loss in a 300-amp welder is 500 w, as compared to 24800 to 3600 w for motor-generator welders, manufacturer states, and the power factor at normal operating load conditions is comparable to induction-motor-driven welders. Welder's efficiency is high, described as 66 per cent at full load increasing to 73 per cent at 20 per cent rated load. Westinghouse Electric Corp.

## 14—HUMIDITY EQUIPMENT

**For control of temperature and relative humidity conditions**

The controlled humidity method is described as a system of air conditioning giving complete control of temperature and relative humidity, holding constant conditions or varying them at the will of the user. Especially, it provides dry air at normal atmospheric temperatures with little or no refrigeration required.

The apparatus is enclosed in a casing through which air is drawn by fans. Filtered air then enters a chamber where it is dehumidified in passing through a spray of "Hygrol" (a hygienic hygroscopic chemical that absorbs airborne moisture and contains no salts or solids).




The same equipment may be used for winter air conditioning by installing a tempering coil at the outer intake, a humidifier, and a reheat coil above the eliminators. Equipment comes in a range of sizes providing from 1000 to 20,000 cfm of conditioned air from a single unit, and multiple unit installations are practical. Niagara Blower Co.

## 15—CAPILLARY BLEEDER

**For use in pressure gages or wherever pressure line must be purged**

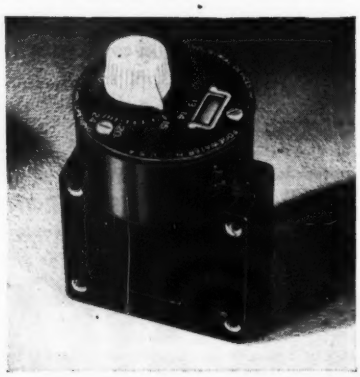
This integral capillary bleeder designed for use with company's Acragage is intended to permit complete purging of air from the bourdon tube at all times. Manufacturer states that it is impossible to completely evacuate air from bourdon tubes and the resulting air bubbles may cause gage inaccuracies. The bleeder is thus expected to be of value on sealed system pressure gages. Clapp Instrument Co.

## 16—SMALL AMMETER

**For operating over wide range in checking flow of current**

The Mini-Amp is described as "burn-out-proof," accurate, dependable, and inexpensive. Of unique design, the current-carrying wire is slipped through the opening in the case of the Mini-Amp, and the knob is turned until the indicator light extinguishes. Then current is read in amperes off the dial.

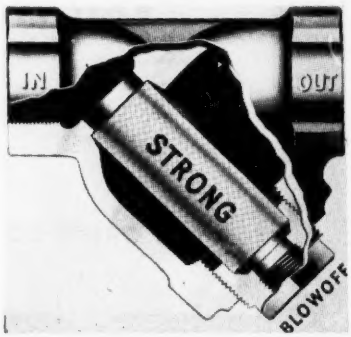
The range may be changed by increasing the number of wire passed through the opening. The scale range of Model 810 is 10-24 amp, but it may be extended down to 0.1-0.24 amp. Industrial Devices, Inc.



## 17—Y-TYPE STRAINER

**For protecting steam traps, reducing valves and temperature controls**

This low cost strainer is recommended for removing impurities such as lint, scale, dirt or sand from steam, air, water or gas. Special features include Monel screen, heavy semi-steel body with self-centering screen guides to




prevent crushing, a screen easily removed for cleaning, gripping lugs on inlet and outlet bosses to permit installation with any type of wrench.

Sizes range from ¼ to 2 in. for steam pressures to 250 psi, or cold pressures to 400 psi. Cast steel strainers are available for steam pressures to 600 psi, in sizes from ¼ to 4 in. Strong, Carlisle & Hammond Co.

## 18—COMBINATION CUP-GAGE

**Combines visible oil cup and visible oil gage in a single unit**

This combination device can be used as a visible oil cup to replenish oil in bearings, transmission and crankshaft cases and also as an oil gage for checking oil levels periodically. Because of the visible feature it can be installed at any convenient distance from the machine.

A clear, shatter-proof plastic bottle is used to keep oil supply always visible. Metal parts are heavily plated for corrosion resistance and easy cleaning. Has large, self-closing filler cap. Heavy steel base is cemented and roll-clinched to plastic reservoir to eliminate possible leakage. Easily installed. Available in 1, 2, 4, and 8 oz capacities. Trico Fuse Mfg. Co.

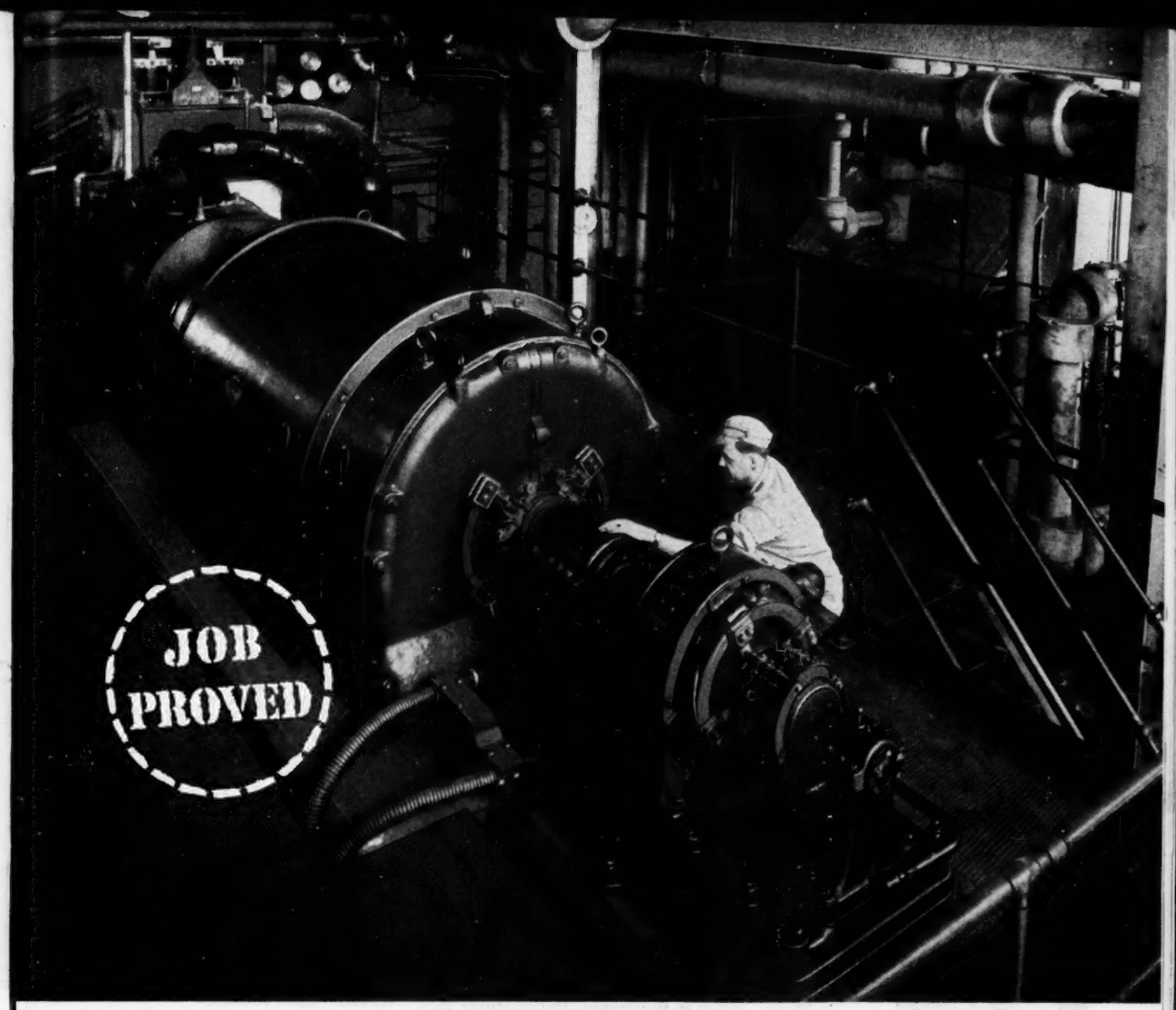
## 19—SOLENOID VALVES

**Electro-hydraulic type, engineered for long service**

This valve has a forged steel body with disc and seat of exelloy. It is recommended for oil or oil vapor service on temperatures up to 1000 F and for steam, water, air, gas and general service on temperatures up to 850 F. The valve is packless, has only three moving parts, and operates from 6 v storage battery.

To open the valve a button is pressed and the solenoid lifts armature to open pilot valve which is held open by permanent magnets. To close valve, the lower solenoid is energized and pulls the armature down to close the pilot valve. Said to be a special feature of this valve is the rod-like member in the piston which acts as a timing valve and which can be adjusted to variable closing of the valve proper so as to eliminate water hammer.

Valves come in forged steel in sizes from ½ to 2 in. screwed or flanged.




# PROTECTED BY SUNVIS 916

**Turbine Bearings and Journals Corrosion-Free Despite Summer Shutdowns — Oils Like New After 9,000 Hours**

Three years ago, a paper mill overhauled a steam turbine. Thereafter, it was planned to operate this equipment on a 'round-the-clock schedule during the six winter months, and completely shut down in the summer. On the advice of a Sun Engineer, the mill charged the circulating system supplying turbine, generator journals, and governor with Sunvis 916. This oil was chosen because of its "Job Proved" ability to prevent rust and corrosion and to give troublefree lubrication for a long period of time.

The management's selection of Sunvis 916 proved to be sound. After 9,000 hours, a laboratory analysis of the oil showed it to be unchanged—comparable to a sample of new oil. Even more important, inspection showed no abnormal wear and no corrosion in bearings and journals, despite the summer-long shutdown.

The turbine has now operated 12,000 hours without oil-change, and it appears that none will be necessary in the foreseeable future.

All oils in the Sunvis 900 series have a high viscosity index, are fortified against oxidation and sludging, and prevent rust and corrosion. Sunvis 900 Oils are the finest lubricants available for turbines, hydraulic systems, and similar applications. For a free, illustrated booklet on Sunvis 900 Oils, write Department PN-12.

**SUN OIL COMPANY** • ***Philadelphia 3, Pa.***
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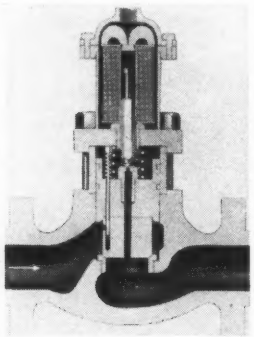
Toronto and Montreal

**SUN PETROLEUM PRODUCTS**
**"JOB PROVED" IN EVERY INDUSTRY**

SUNOCO

Corrosion resistant solenoid valves in ¼ to 3 in. sizes are available in a variety of materials. Also available are



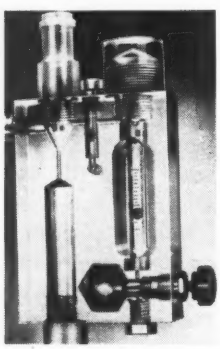
high pressure corrosion resistant valves in 1 to 10 in. sizes. A. F. Hoppe Engineering Inc.

## 20—CHEMICAL FEEDER

**Is compact, self-contained unit made of transparent acrylic plastic**

Measuring about 10 by 5 by 2 in. overall, the Feed-Rator is designed to simultaneously control, meter, and dispense relatively small amounts of bactericides, catalysts, disinfectants, fungicides, inhibitors, reagents and other chemicals into a larger stream. By means of the built-in eductor, corrosive chemicals can be fed directly from a container, it is pointed out.

The unit is built to treat up to 7000 gal per day of water directly. In a bypass arrangement, using a solution containing 5 per cent active reagent by weight, 5 ppm of the reagent can be delivered to over 14,000,000 gal of water a day, according to manufacturer. Fischer & Porter Co.



Feeder

Valve

## 21—ATOMIZING VALVE

**For deaerating heaters, vacuum deaerators, hot process softeners**

This valve is a proportioning type, engineered to insure uniform atomization under all load conditions. It is described as non-clogging and designed to provide a tangential spraying action and atomization of incoming water to droplet form. Operating tests are said to show "zero" oxygen after atomization in a steam atmosphere.

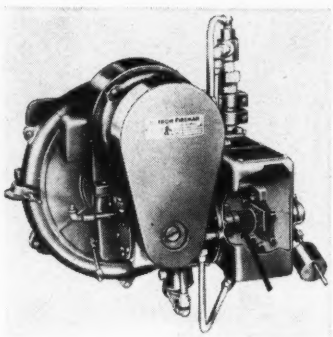
The valve has an external stem and is diaphragm operated. The diaphragm may be actuated by a float cage pilot or differential orifice.

Compact design is intended to permit easy installation or removal for inspection, or for installation in existing equipment for modernization or increasing capacity. Sectional design of the valve also permits increasing capacity by the addition of additional sections. The valve is available in capacity ranges up to 2000 gpm. Belco Industrial Equipment Div., Inc.

## 22—VARIABLE VOLUME PUMP

**For industrial oil burners, it meters fuel to rotary atomizing cups**

With the Oil Volumeter, a positive displacement pump submerged in the oil reservoir, company's oil burners can burn any weight of industrial oil from No. 1 to No. 6 or Canadian Bunker Q oil without manual adjustment, it is announced. The amount of oil fed to burner is determined by the movement of pistons in multiple cylinders. The rate of feed is governed by length of piston stroke, which in turn is controlled by a cam mechanism. It is claimed that neither oil temperature nor viscosity affects feed rate.



A gear-type pump with return flow to oil tank is intended to maintain a full reservoir with reserve oil capacity. Air from the suction line is automatically vented from top of reservoir to keep air out of the oil in which Volumeter is submerged. Manufacturer says that this pump eliminates unsteady fire and starting failures which often hamper the use of low-cost but high-heat industrial fuel oils. Iron Fireman Mfg. Co.

## 23—HEAVY DUTY FLOODLIGHTS

**For general lighting or flood-lighting, service come in two wattages**

The Type L-84 Floodlight rated at 500 w and the Type L-85 rated 1000 w are available in a complete range of NEMA

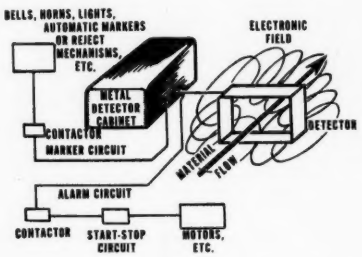
types 1 through 5. Weather-tight and constructed of heavy-gage aluminum, each of the units weighs less than 17 lb. Non-corrosive materials — aluminum and stainless steel—are used.

An auxiliary reflector of finished aluminum provides high beam efficiency. The floodlights can be provided with either narrow-beam polished or wide-beam etched reflectors. Both the L-84 and the L-85 are available in three standard mountings, including a portable base. Lighting and Rectifier Divs., General Electric Co.

## 24—METAL DETECTOR

**Is electronic device for detecting metal in nonmetallic materials**

This metal detector is designed to detect metal of any kind in rubber, limestone, lumber, textiles, coal. The equipment




consists of the detector or search coil, usually custom built to surround the material flow in the inspection area, and a water tight metal control cabinet, housing the electronic and control relays which are mounted in any location within reasonable distance.

In the detection of tramp metal the product to be inspected is conveyed by belt to the search coil where it enters an electro-magnetic field. If foreign metal is present the detector will automatically stop the belt, or operate signal devices.

The minimum size of metal particle detectable is generally dependent upon the size of the search coil and the "product effect" of the material being handled. Unit operates on belt speeds up to 900 fpm. Eriez Mfg. Co.

## 25—LOAD TAP CHANGER

**Is single, self-contained unit enclosed in a steel tank**

The Type URS Load Tap Changer is now standard equipment on company's step-type feeder voltage regulators up to ratings of 750 kva, three-phase, and up to 69 kv in voltage. It can also be applied to power transformers, 15,000 kva and below; unit substations; company's CSP power transformers.

Smooth acceleration and deceleration with high speed from one tap position to another and positive alignment at each position is said to be achieved by geneva gears which permit direct connection between contacts and the driving motor.

A separate air compartment within

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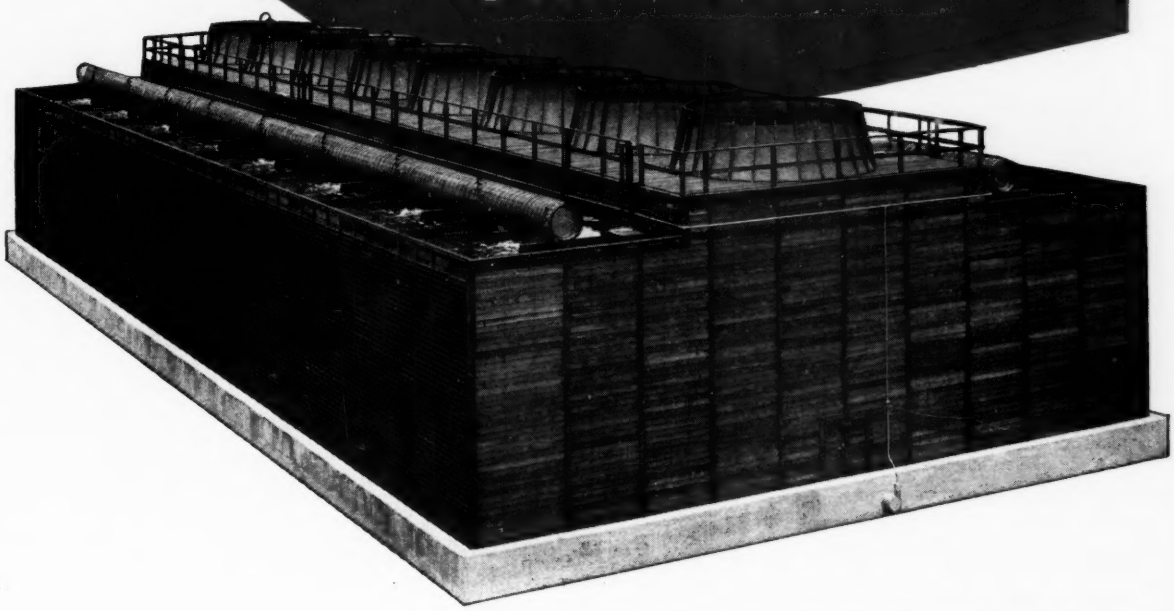
# control SLIME and ALGAE...

# SANTOBRITE



Santobrite—Monsanto's Sodium Pentachlorophenate, Technical—offers you these advantages for elimination of slime and algae in cooling water systems:

1. Maximum control of algae and slime-forming organisms.
2. Requires no special feed equipment (merely add to circulating water at any convenient location).
3. Compatible with other chemical treatments given cooling water.
4. Non-corrosive to metals.
5. Easy to apply in powder, briquettes or new dustless pellet form (for those who find Santobrite dust bothersome).
6. Readily available at reasonable cost.

Santobrite provides an economical means of maintaining peak efficiency in your cooling operations... For more detailed information, send for a copy of Monsanto Technical Bulletin O-15. MONSANTO CHEMICAL COMPANY, Desk F, Organic Chemicals Division, 1765 South Second Street, St. Louis 4, Mo.

**SANTOSITE...**
**Controls oxygen corrosion in boiler systems**

By removing all traces of residual oxygen, Santosite makes possible economical control of oxygen corrosion in boiler tubes and other steam generating equipment. For detailed information on the Santosite treatment, ask for a copy of Monsanto Technical Bulletin O-26.

*Santobrite, Santosite: Reg. U. S. Pat. Off.*

MONSANTO
CHEMICALS AND PLASTICS

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Please send me: ( ) Technical Bulletin O-15 on Santobrite;
( ) Technical Bulletin O-26 on Santosite for boiler feed water.

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Company_____

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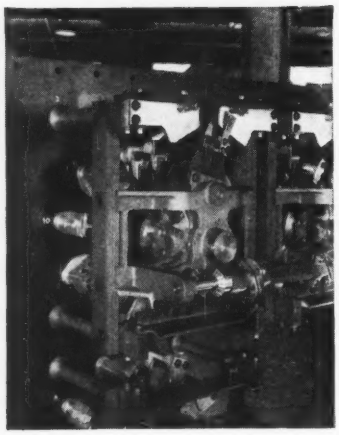
SERVING INDUSTRY...WHICH SERVES MANKIND

Mark the numbers of the items you wish to receive on the no obligation, no postage card. Pages 35-36.

the tank contains auxiliary switches, equipment for position indication, and hand operation, a mechanical stop, and



an operation counter, together with gearing and shafting. The compartment is accessible through a gasketed, hinged door. Removal of the hand crank from its socket on the inside of the door de-energizes the motor and control circuits through an interlock switch. Westinghouse Electric Corp.

## 26—ELECTRONIC STARTER

**For fluorescent lighting, is engineered for increased safety**

This electronic safety starter is intended to eliminate fires, short circuits and transformer burn-outs in fluorescent lamp fixtures. It is also expected to reduce repair and maintenance costs. Called the Automatic Safety No-Blink Starter, it is described as an efficient thermostatic relay switch.

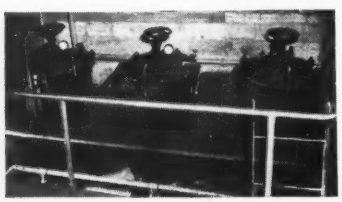
Company spokesmen point out that a fluorescent lamp is supposed to light when its starter shoots a high voltage current across the lamp. However, a defective lamp will not light when this charge is delivered. Many starters thus create a hazard by passing a high voltage charge to the lamp indefinitely.

This is said to be impossible with a Suclar Safety Starter. If it is called on to light a lamp which fails to light within 30 sec, a thermal relay automatically switches off the lamp. Suclar Laboratories, Inc.

## 27—OIL REMOVAL PROCESS

**For removing cylinder oil from condensate return**

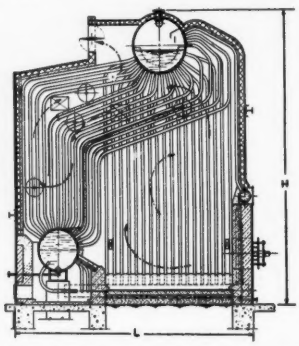
This new process has been in operation on a 2000 hp installation for over eight months, manufacturer reports, with remarkable efficiency noted. In this installation cylinder oil in the condensate has been reduced from 20 ppm to less than 1 ppm with a flow rate of 2½ to 3½ gpm per sq ft of filter area at 125 to 160 F, with oil removal constant. The process consists of the constant mixture of a slurry of an oil absorbent in water by a proportioning pump and filtering through paper. Sparkler Mfg. Co.



## 28—TWO-DRUM BOILERS

**Are standardized in capacities from 10,000 to 45,000 lb steam per hr**

The Type C standardized boilers feature a bent tube design which is compact and symmetrical. Gases enter tube bank across the entire width of furnace, and full width flow is maintained through entire unit, it is stated.



These boilers also feature a water cooled furnace design said to be particularly effective for minimum furnace maintenance. In sizes of 20,000 lb and over, the furnace is completely water cooled. Below 20,000, the design provides for side walls without water cooling. Superheater, air heater and economizer can be furnished. Firing equipment can be furnished for coal, oil or gas.

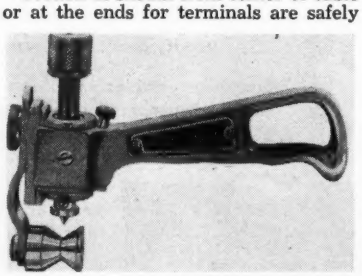
Capacity varies with width of furnace. Overall height and depth are the same. Springfield Boiler Co.

## 29—CABLE STRIPPER

**For stripping sheath from lead, armored, rubber or plastic cable**

The yoke and roller swivel arrangement of this cable permits either circumferential or straight cuts to be made at any predetermined point on the cable, according to manufacturer, and the entire operation is done with one hand and without effort on the part of the operator.

Section of sheath from center of cable or at the ends for terminals are safely

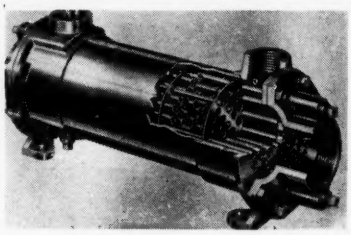


and easily removed without injury to the wires, it is stated. The strippers are made in several models to meet requirements of various kinds of cable. Their weight is approximately 7 oz for the small size to 10 oz for the larger size. They are precision built to provide for long life and trouble free operation. Taca Co.

## 30—HEAT EXCHANGER

**Is fully standardized unit, of Type 316 stainless steel**

Immediate delivery and low unit cost of this all-stainless steel heat exchanger are possible, states manufacturer, because of complete standardization and stocking of all component parts. Identical in design and capacities to company's all-copper and copper alloy



units, the new Type SSCF model utilizes stainless to avoid contamination of fluids or corrosion by fluids.

This exchanger is offered in a complete range of sizes tested to 450 psi to withstand strenuous usage. While Type 316 is standard because of its widespread acceptance in industry, SSCF exchangers can be made to order from other types of stainless steel. Ross Heater & Mfg. Co.

## 31—METAL PRIMER

**Is multi-purpose coating, can be applied by brush or spray**

Led-Chroxide is a blend of red lead, zinc chromate and iron oxide in combination with a specially developed vehicle. It is described as a moisture proof metal primer more rustproof than either red or zinc chromate when used by themselves.

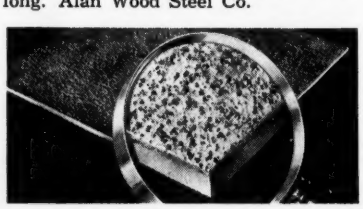
Led-Chroxide has a tough, highly impermeable and rust-resistant film, company points out, which provides an ideal foundation for finish coats. It is said to dry tack free in 2 to 3 hr, overnight for finish coats. It covers approximately 500 to 600 sq ft per gal, one coat, on smoth surfaces. Has complete hiding power in one coat, it is said, and won't check, peel or crack. Thomson-Porcelite Paint Co.

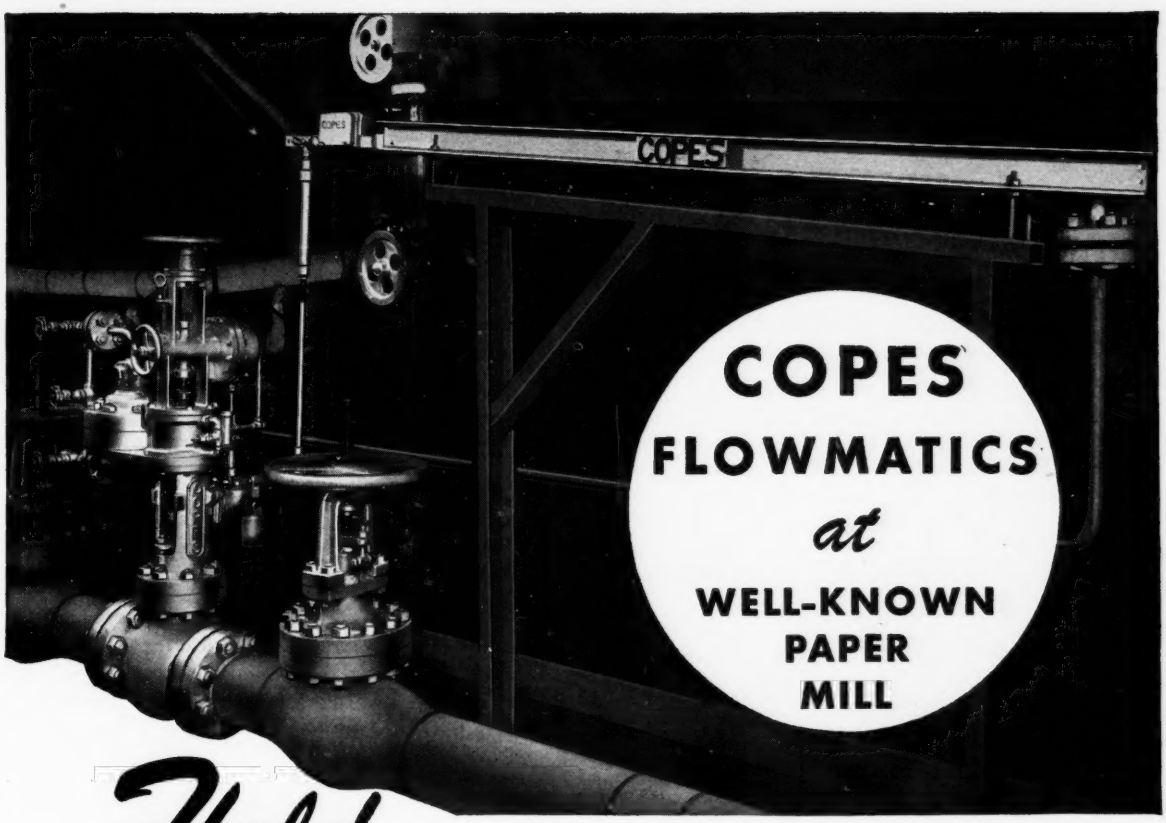
## 32—NON-SKID FLOOR PLATE

**For sure footing, is made of rolled steel and abrasive grain**

The A. W. Algrip Floor Plate is recommended for industrial floors, loading platforms, ramps, walkways, trench and hatch covers and wherever there is danger of men slipping and hurting themselves. With it there is claimed to be no slipping. As the surface wears, new abrasive particles are exposed.

Abrasive grain is rolled as an integral part of the upper portion of the steel plate. It can be sheared, drilled, countersunk, machined and flame cut, according to company, but flanging is not recommended. Plates are available in thicknesses from ⅛ to ⅜ in. and in sizes up to 60 in. wide by 144 in. long. Alan Wood Steel Co.






# *Hold* CLOSE WATER LEVEL on fast-steaming boilers taking rapid swings

Here is one of two COPES Flowmatics serving 810-psi, 825-F C-E Type VU boilers in one of New York State's most modern paper mills. Rated at 110,000 pounds per hour, each boiler is subject to a sharp load change every three minutes. Despite this severe service, drum water level is held within plus-or-minus one inch.

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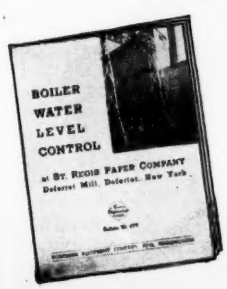


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**Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.**

# NO "FREEZE-UP" with YARWAY TRAPS

Yarway Traps best the worst weather in this installation at Thermoid's Trenton plant.

Troubled with outdoor steam traps freezing? Solve the problem the way Thermoid did at their Trenton, N. J., plant.

They installed Yarway Impulse Steam Traps on coal handling equipment. Now, though temperatures dip to zero and snows pile high, their traps never freeze.

Condensate does not accumulate in Yarway Impulse Traps. The only moving part—a little valve—floats on the load. It discharges condensate as it comes through, instead of waiting for a quantity to accumulate. Hence —nothing to freeze.

Add to that, Yarway Traps' reputation for low maintenance, quick heating, easy installation, and economy of operation and you have reasons why over 600,000 Yarways have already been bought.

Often it costs less to install new Yarways than to repair old type traps. See your nearest Mill Supply Dealer. For his name, and free Yarway Trap Book, write . . .

**YARNALL-WARING COMPANY**
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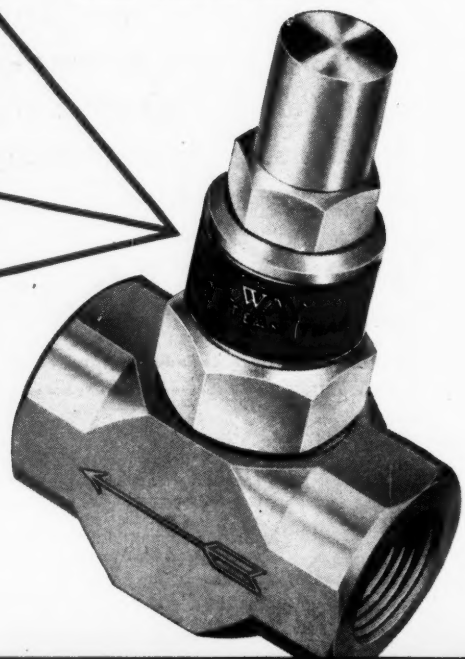

**YARWAY IMPULSE STEAM TRAP**

# LETTERS TO THE EDITORS

## COMMON SENSE ISN'T AS COMMON AS IT SHOULD BE

NEARLY EVERY accident report that lands on my desk recalls the old story of the former chief justice of the Supreme Court who was returning home one evening when the hub of the wheel on his buggy caught on a small sapling which was growing by the roadside. After trying unsuccessfully to release the wheel he heard the sound of an axe in the woods and hailed the negro who was wielding the axe. "If you will use your axe to cut down this sapling, I'll give you a dollar," the judge said.

The negro approached and simply backed the horse around until the wheel was clear of the sapling and then brought the carriage safely around it." You surely don't charge a dollar for that do you?" asked the astonished judge. To which the negro replied:" No sir, but its sure worth a dollar to learn some folks some sense."

In that little story about the wise judge who failed to use his head to get himself out of a small difficulty we have something that is related to present day accident frequency rates.

Almost any analysis of any group of accidents proves beyond reasonable doubt that many humans are failing to put to good use the common sense that all of us are supposed to posses. And if you think that is a lot of the old malarki let's look over a few recent accident reports and see how careless habits of humans who know better but don't do better are keeping business good for the grave diggers.

One employe placed an unopened step ladder against the end of a power panel, climbed to the top of ladder and the ladder slipped. Another tried to use his screwdriver as a pry; the screwdriver broke under the strain and the broken point landed in his eye. In a similar accident the employe used his screwdriver to pry up a manhole cover, the tool slipped, the cover fell and the worker received three broken toes. The prize of them all is the report on the worker who were his goggles on his forehead while he drilled a hole into a brick wall. A piece of steel broke off the drill and landed in the worker's eye that would have been protected had the employe worn his goggles over his eyes instead of pushed up on his forehead.

The use of good old common sense would have prevented any of the accidents just described and perhaps safety would receive a definite boost if workers were urged to let common sense tell them whether their work routines are safe or unsafe.

Almost all of the human behaviour actions that contribute to accidents can be classified under five headings: (1) Doing the wrong thing; (2) failing to do the right thing; (3) overdoing the right things; (4) not doing enough of the right thing, and (5) wrong timing. And each of these five actions can be traced to failure to use common sense in the performance of job routines.

Sometime ago our company took a long look at the common sense side of our accident picture and decided to use a bit of psychology to aid in reducing the number of injuries. Our plan wasn't a new one; safety directors have known for a long time that every individual possesses normal desires. They desire safety; desire to avoid personal loss; desire to prevent injury to others; desire to avoid creating an unfavorable impression; desire to avoid punishment, and desire leadership. Safety programs that hit home to the more commonly felt desires of the workers, appeal to such traits of characters as: Selfishness, ambition, pride, compassion, sense of responsibility, sense of loyalty, imagination and even patriotism.

Our campaign with its awards for best safety performances is directed to appeal to the trait of ambition and the desire to excel. Our "Booby Prize" is directed at the trait of pride; the contestants being stimulated to escape a designation which makes them appear ridiculous. Our bulletins, picturing burns, mashed fingers, etc., are directed at the fear of personal injury.

Our foremen and supervisors appeal to the workers' same traits and desires that have been successfully appealed to in getting quantity and quality production. A man who is a proud craftsman will not wish to injure the fingers and hands which he has trained. Another has worked hard for advancement and better pay—he will not risk the loss of income as a result of injury. Another is a devoted family man, planning for his family's future—he will not wish to risk injury for fear of injuring the future of his family.

During the campaign management has learned more than it ever knew about the common sense side of safety. We have learned that repetition is the basis of learning; that one safety bulletin covering our "No Smoking" rule does only part of the job; it takes a constant flow of interesting bulletins on the subject to keep employees conscious of the rule. We have found that the emphasis in safety should be put on what to do rather than what not to do. Also high on the list of facts that we have discovered since we started making safety appeal to the desires and traits of character of our workers are: (1) It's easier to form a new habit than to lose an old one; (2) it's easier to impart new ideas or new knowledge than to correct misinformation, and (3) education is slow and adult reeducation is even slower.

Those few bits of knowledge have been of real assistance in our campaign to reduce accidents. In one particular type of accident known as hand truck injuries which were quite common around our plant our campaign has prevented many injuries. When we started in on this particular type of accident we had the facts well digested: in three out of five cases unsafe conditions were contributing causes; in nine out of ten cases the injured worker was working unsafely. Failure to wear safety shoes accounted for one-fourth of the unsafe conditions; defective conditions — such as loose wheels, broken handles, broken legs, defective mechanisms on lift trucks —caused one-sixth of the accidents charged to unsafe conditions.

JOHN G. REYNOLDS

## THOUGHTS ON A PRACTICAL THERMOELECTRIC GENERATOR

THE ARTICLE ENTITLED, "A Practical Thermoelectric Generator" which appeared in a recent issue of POWER GENERATION, was well worthwhile as a thought instigator. I recall in my high school in Brooklyn, New York, we had a small thermoelectric unit, gas heated, which indicated a generative effect. It had no identifying markings, but it served to show that electricity could be generated directly from heat. Perhaps the voltaic pile may return to consideration.

In transmission line survey work in which I participated years ago in certain areas, compass readings taken after the sun rose or was in evidence gave unreliable records doubtless due to the magnetic effect due to the field set up through the presence of the local currents resulting from the nature of the soil strata. It seems to me that there are many effects of this kind, of which little is known, that would offer good material for investigation through the means of student theses in colleges and universities.

The May-June 1949 issue of *Water Power*, a British publication,

*(Continued on page 71)*

# Huey Station Gas Turbine Opens New Chapter in Power Generation

FIRST PUBLIC SHOWING of a central station installation of the gas turbine, held on October 3 in Oklahoma City, marked the end of long years of pioneering and the successful beginning of a new chapter in power generation in the United States. The unit, a General Electric 3500-kw simple-cycle gas turbine power plant, is installed at the Arthur S. Huey Station of the Oklahoma Gas and Electric Co. It is the first commercial stationary gas turbine unit, for power production only, to go into operation in the United States.

As of October 13, in more than 1500 operating hours, the gas turbine has produced approximately 5,250,000 kwhr at an average of 3557 kw. Operating data as of September 23, 1949 are shown in Table I. In announcing the first results of the firing, C. C. Willis, superintendent of generating stations of OG&E, said, "On September 28, the gas turbine permitted a pick-up in total station output from approximately 51,000 kw to 58,000 kw with an over-all improvement in plant operating economy. Of this pick-up, the gas turbine carried approximately 4000 kw and the balance of 3000 kw was achieved in plant operation. The gas turbine has carried as much as 4300 kw during this time."

The gas turbine was shipped to OG&E in March 1949 and was put on the line July 28. Although it was impossible to fire the turbine during its test at G.E.'s Schenectady plant on natural gas, for which it was designed, it has exceeded all expectations since firing, many times operating above its rated capacity, according to Mr. Willis.

Prior to installation of the gas turbine, the Huey Station had a rated capability of 56,000 kw, but limitations in maximum heat input to boilers produced a capability of only 51,000 kw.

This gas turbine power plant, Fig. 2, represents the first commercial application in this country for central station use of the design principles first used in the aircraft jet engine, and is much like the 4800-hp locomotive gas turbine now in regular freight service as part of its road tests in California. (See POWER GENERATION, July 1949.)

The new gas-fired unit is installed in a building of less expensive construction added to one side of the existing plant, Figs. 3 and 5. The building has a standard crane and power hoist operated from the floor. A large door allows trucking or dollying any part of the equipment into the main plant machine shop.

The weight of the complete power plant including the compressor and gas turbine unit is only 25,000 lb. The complete unit, including the

Fig. 1. Schematic diagram of 3500-kw simple, open-cycle gas turbine generating set installed at Arthur S. Huey Station of Oklahoma Gas & Electric Co.

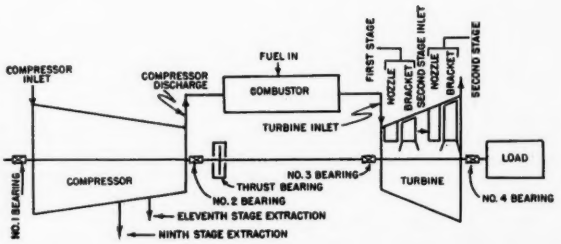


Table I. Operating data for 3500-kw gas turbine power plant as of September 23, 1949

| (As Of Sept. 23, 1949) | |
|---|---|
| Date in Service | July 29, 1949 |
| Total Hours Operation | 1,078 |
| Kwhr Generated | 3,749,000 |
| Average Load, kw | 3,478 |
| Maximum Load, kw | 4,300 |
| Average Inlet Air Temperature, Deg F | 71 |
| Average Turbine Exhaust Temp., Deg F | 780 |
| Average Flue Gas to Stack Temp., Deg F | 340 |
| Btu per kwhr Gas Turbine Only | 21,960 |
| Btu per kwhr Combination With Steam, Net | 16,220 |
| Average Plant Pick-up by Combined Operation During Period Covered Above, kw | 5,500 |
| Plant Pick-up Under Favorable Conditions, kw | 7,000 |
| Station Capability Under Most Adverse Conditions, kw | 58,000 |
| Cost Per kw of Combined Increased Capability, $ | 104 |

Table II. Test data, 3500-kw load at sea level and 80 F inlet, for gas turbine power plant

| | PRESS. PSIA | TEMP. DEG F | LUBE OIL TEMP. DEG F | FLOW M LB/HR | POWER KW |
|---|---|---|---|---|---|
| Comp. Inlet | 14.7 | 80 | | 339 | |
| 9th Stage Ext. | 38.0 | 320 | | | |
| 11th Stage Ext. | 47.0 | 370 | | | |
| Comp. Discharge | 85.4 | 500 | | | |
| Turbine Inlet | 78.7 | 1290 | | | |
| 1st Stage Bucket | | 1000 | | | |
| 2nd Stage Inlet | 26.2 | 965 | | | |
| 2nd Stage Bucket | | 875 | | | |
| Turbine Exhaust | 14.7 | 780 | | | |
| Bearings | | | | | |
| Oil Inlet | | | 128 | | |
| Oil Outlet | | | | | |
| No. 1 | | | 147 | | |
| No. 2 | | | 155 | | |
| Thrust | | | 172 | | |
| No. 3 | | | 160 | | |
| No. 4 | | | 146 | | |
| Load | | | | | |
| At Generator Terminals | | | | | 3500 |
| Fuel Required (Gas) | | | | 83.4M Btu per hr | |
| Water Requirements, Generator Air Cooler & Oil Cooler | | | | 320 gpm | |

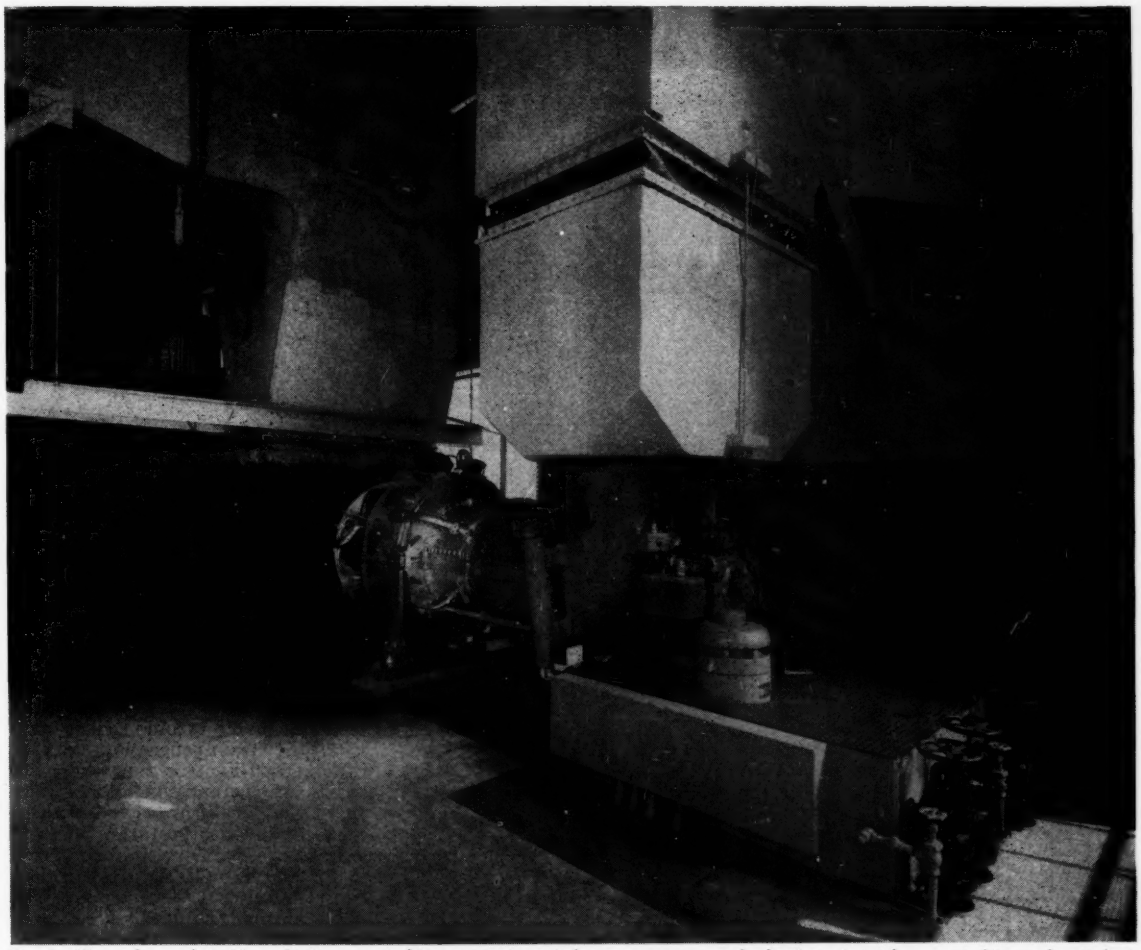

Fig. 2. View of complete Huey Station gas turbine generator set from compressor end, showing air intake, gas turbine, exhaust duct leading to heat exchanger outdoors and, at rear, generator driven by turbine

generator and exciter is less than 50 ft long and 9 ft wide, and located all on the same floor level with the exception of the oil tank. Consequently, installation problems are very simple, since minimum foundation is needed for support. The foundation loading is low, carrying a total of only 85,000 lb.

The design of the gas turbine power plant, which eliminates the need of much of the bulky equipment demanded by steam generating units, according to the manufacturer, makes it especially desirable for adding capacity to existing stations. The small size of the building housing the unit contrasted to the over-all size of the plant, Fig. 4, indicates the economy in installation achieved through the use of the gas turbine for this purpose.

Operating on natural gas, which is

Table III. Installation cost data for 3500-kw Huey Station gas turbine power plant

| | |
|---|---|
| Buildings, Grounds & Foundations | $ 79,851 |
| Gas Turbine Unit Erected | 400,107 |
| Automatic Control | 28,393 |
| Recuperator Erected | 91,140 |
| Stacks, Duct Work | 32,548 |
| Air Intake Cooler | 9,237 |
| Piping | 51,225 |
| Electrical | 34,486 |
| Miscellaneous | 3,013 |
| | $730,000 |

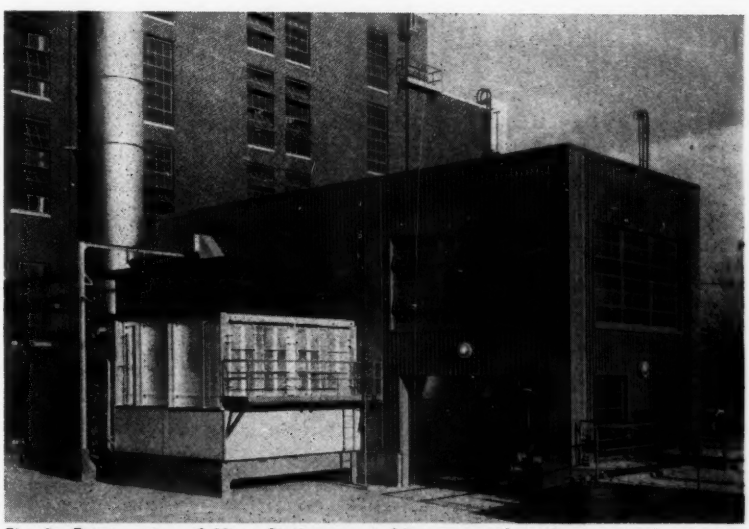

Fig. 3. Exterior view of Huey Station gas turbine power plant showing simple structure added to station to house gas turbine unit. Heat exchanger (recuperator) at left

Fig. 4. Switchboard Cabinetrol for gas turbine power plant

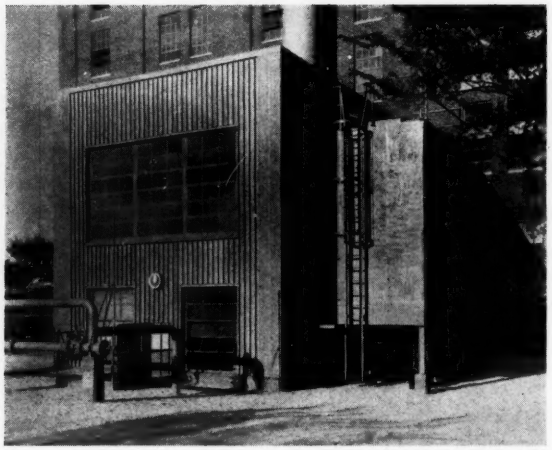

Fig. 5. Exterior view of Huey Station gas turbine power plant, showing air cleaner and precooler

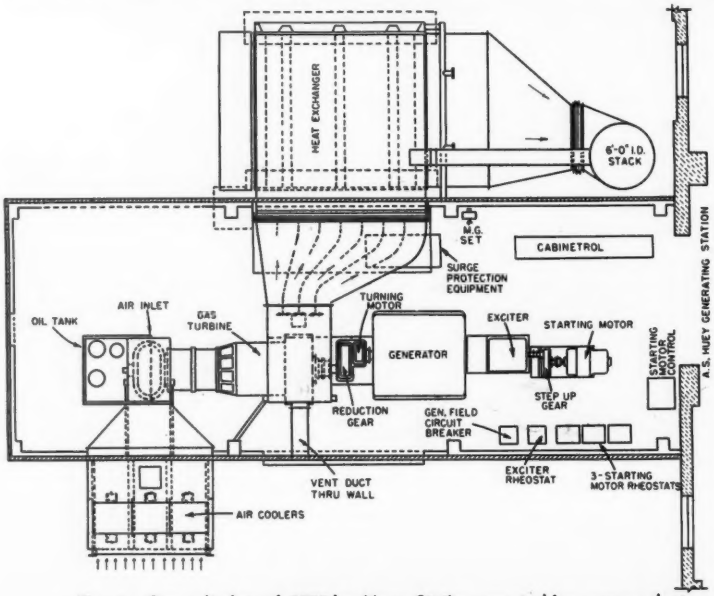


Fig. 6. General plan of 3500-kw Huey Station gas turbine power plant

abundant in the area, the turbine makes available more total power than that which it generates itself, see Table I. The waste heat from the exhaust is used with a separate heat exchanger, Fig. 3, to supplement the present boiler feed water heating system. By supplementing the heating capacity of the installed equipment, better utilization is made of the available turbine shaft capacity of the steam generating units.

Two 5000-kw gas turbine power plants are currently being manufactured and are scheduled for shipment in the near future. One will go to the Public Service Co. of Oklahoma and the other to Bangor & Hydro-Electric Co. in Maine. The latter unit will be fired with Bunker C oil.

The Huey Station gas turbine power plant has been described in detail in a number of ASME papers and technical magazine articles. As shown, it consists of a simple, open-cycle gas turbine, nominal rating 3500-kw, designed for inlet temperature of 1450 F but found capable of developing full load at lower temperature, see Table II, direct connected to a 15-stage axial compressor operating at 6700 rpm.

The compressor supplies air to six combustors fired with natural gas furnished at 100 psi. Air is extracted at intermediate stages of the compressor to cool various parts of the turbine.

The gas turbine drives a conventional 4000-kw, 3600-rpm generator and shaft mounted exciter through a precision helical gear.

Air is supplied to the air compres-

*(Continued on page 71)*

Fig. 7. Another view of 3500-kw gas turbine plant with identification placards, as shown for first time October 3 to petroleum engineers at ASME meeting in Oklahoma City. Left to right: A. A. Hafer, field engineer, G. E. Co.; Ralph Randall, Oklahoma manager, G. E. Co.; George Conley, chief engineer, Huey Station

Fig. 1. General view of Hickling Station, New York State Electric & Gas Corp., East Corning, N. Y., showing coal storage area for approximately 30,000 tons of No. 4 buckwheat anthracite. Condenser circulating water intake at lower right, through which about 32 mgd of water is drawn from Chemung River. Lower left—Part of outdoor 33-kv and 114-kv substation. Plant now contains one 35,000-kw turbine generator and two boilers. Named as memorial to William G. Hickling, vice president and general manager of New York State Electric & Gas Corp.

# HICKLING STATION

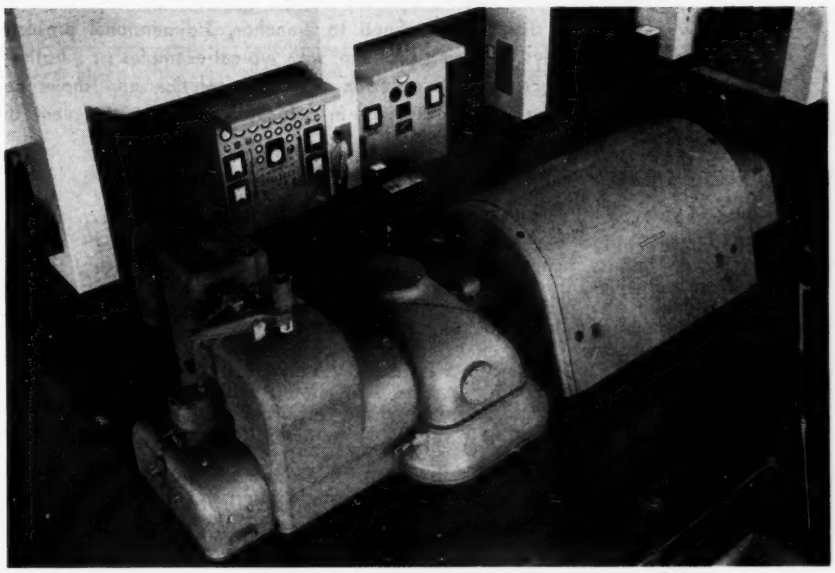

Fig. 2. View of the 35,000-kw, 3600-rpm, 13,800-v turbine generator installed in Hickling Station. Generator hydrogen cooled. Many turbine and boiler auxiliaries are in duplicate, with automatic switchover devices to insure continuity of service. More than 100 electric motors, up to 450 hp, drive auxiliaries. Turbine receives throttle steam at 885 psi, 910 F. Regenerative feed heating cycle.

Hickling Station is part of New York State Electric & Gas Corporation's long range construction program to meet increasing demands in its area. This program includes doubling capacity of Jennison Station, Bainbridge, N. Y. to 70,000-kw and Greenridge Station, Dresden to 88,000 kw in 1950. A scheduled expansion will also increase Goudey Station, near Binghamton to 169,000 kw by addition of a 75,000 kw unit at this station

Fig. 3. View of the two steam generating units at Hickling Station. They are fired with No. 4 buckwheat anthracite, burned on traveling grate stokers, each 24 ft wide and 28 ft long. Induced-draft fans are driven through magnetic couplings; forced-draft fans supply preheated air at 290 F to the various sections of the stokers. Economizers are also installed and flue gas is cleaned by precipitators

# Let the Flexibility Prism Help You Analyze Pipe Stress

**Here is a new concept in 3-dimensional pipe stress analysis . . . Of interest primarily to power piping designers and engineers who calculate pipe stresses in high-pressure, high-temperature piping . . . This is not a news article but a technical discussion leading up to some conclusions . . . Author explains first the general types of problems in piping caused by temperature expansion in addition to pressure stresses . . . Most of discussion confined to 2-anchor, 3-dimensional problem . . . Outline of different ways of solving problem, with typical examples . . . Author then proposes the Flexibility Prism as a criterion to aid in solution and shows how to apply it . . . Method on trial for 3 years in actually working power plant design problems**

By **CHARLES H. GREEN**, Engineer, Lutz and May, Consulting Engineers

IN DESIGNING piping layouts for steam power plants, chemical plants and oil refineries, the engineer must consider the possibility of failure of the piping system by temperature and pressure stresses that arise when the lines reach equilibrium under operating conditions. The purpose of this article is to bring together essential available information on the analysis of piping layouts and to present a simple criterion that may aid in analysis of piping problems.

A typical problem might consist of conveying steam from the outlet of a boiler to the inlet of a steam turbine. Operating conditions of temperature and pressure would be known as well as the material and dimensions of the pipe. A preliminary survey would indicate that the steam line should follow a certain defined path in order to miss structural members of the building and equipment in the plant. The task then is to determine whether or not the maximum combined equivalent stress exceeds the allowable combined stress set forth in the piping code. If it is found that the allowable stress has been exceeded then the layout must be changed and reanalyzed until the maximum stress is not exceeded.

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### Types of Problems

Pipe bend problems may be classified generally as follows:

(1) Single-plane, two-dimensional
(2) Two-anchor, three-dimensional
(3) Three-anchor, three-dimensional

Figure 1-A illustrates the single-plane, two-dimensional problem. As the name implies all elements, AB, BC, CD, and DE lie in one plane. Ends A and E are considered fixed

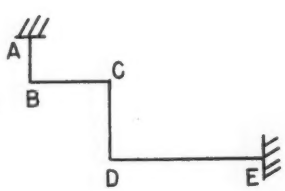



FIG. 1-A

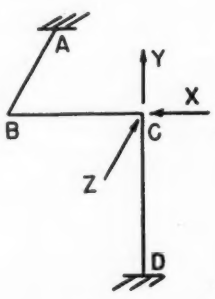



FIG. 1-B

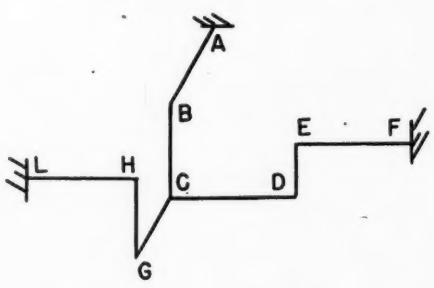



FIG. 1-C

Figs. 1—A, B and C. Diagrams illustrating three typical piping stress problems. A—Single-plane, 2-dimensional piping, ends A and E fixed, all piping in one plane. B—The 2-anchor 3-dimensional piping layout, in which the piping follows any 3-dimensional path from A to D. C—The 3-anchor, 3-dimensional problem, with three end anchors A, L and F

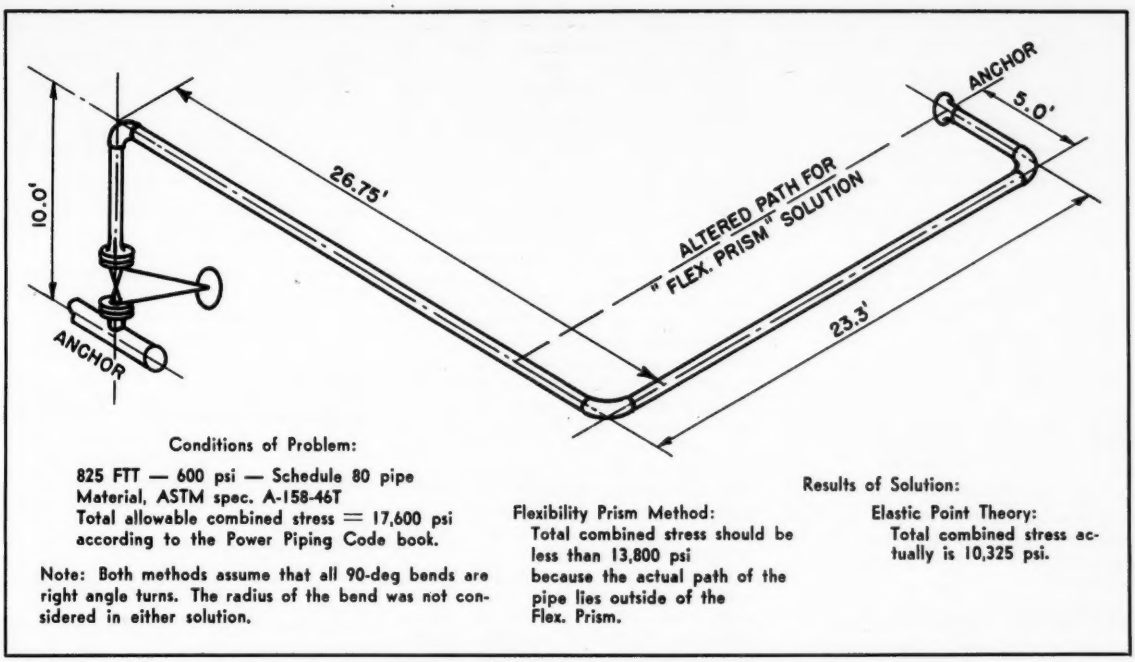

10.0'
26.75'
ANCHOR
ANCHOR
5.0'
ALTERED PATH FOR
"FLEX. PRISM" SOLUTION
23.3'
Conditions of Problem:
825 FTT — 600 psi — Schedule 80 pipe
Material, ASTM spec. A-158-46T
Total allowable combined stress = 17,600 psi
according to the Power Piping Code book.
Note: Both methods assume that all 90-deg bends are right angle turns. The radius of the bend was not considered in either solution.
Flexibility Prism Method:
Total combined stress should be less than 13,800 psi because the actual path of the pipe lies outside of the Flex. Prism.
Results of Solution:
Elastic Point Theory:
Total combined stress actually is 10,325 psi.

Fig. 1—D. An actual example of power plant piping of the 2-anchor, 3-dimensional type, with solutions tabulated and related to the Flexibility Prism criterion as explained in this article

against rotation and displacement. End A might be attached to the boiler outlet and end E attached to a steam turbine inlet.

### The 2-Anchor 3-Dimensional Problem

Figure 1-B illustrates the two-anchor, three-dimensional problem. Elements AB, BC, and CD might have followed any three-dimensional path from A to D. Points A and D represent the two fixed anchors. The coordinate axes X, Y, and Z represent the three directions that a pipe element might follow.

Figure 1-C represents the three-anchor, three-dimensional problem. The three end anchors are A, F, and L. Each anchor-point is prevented from moving in the direction of each of the coordinate axes. Each anchor also prevents rotation in the three coordinate planes.

There might be more end anchor points than three, but such problems are beyond the scope of this discussion.[1] The example that is to be the main subject of this article is the two-anchor three-dimensional problem.

Look now at the elastic behavior of the layout in Fig. 2. If the weight of the structure is neglected and the restraint at D is released, it is apparent that the change in temperature from cold conditions would cause the elements AB, BC, and CD to elongate to the new position indicated by the dotted lines. Forces applied in the positive directions of the coordinate axes at the point D, and of sufficient magnitude to cause the end point to regain its original position, will cause the system to be in equilibrium except for rotation of element CD in the coordinate planes. Next apply moments about each of the coordinate axes to cause the rotation of the end to be zero in any plane. The three forces, $F_x$, $F_y$ and $F_z$ plus the three moments, $M_x$, $M_y$, and $M_z$, as shown in Fig. 2 have caused the structure to be restrained in the same manner as though end D had never been allowed to move unrestrained.

The weight of the pipe is actually disregarded in the analysis of such problems because very flexible spring supports in sufficient number are located so that the weight of the system is carried on an imaginary cushion, to allow perfect freedom of movement in any direction. Effect of the pressure of the fluid inside the steam line will be discussed later under stresses.

The real problem that presents itself now is the determination of the magnitude of the three forces $F_x$, $F_y$, and $F_z$ and the three moments $M_x$, $M_y$, and $M_z$. If these were known the maximum combined bending moment and torsional moment at any other point in the structure could be calculated and the maximum combined stress could be computed.

### Important Stresses Defined

Before continuing, the important stresses that are set up in the structure must be defined. The stresses[2]

[1]Design of Piping Systems; by the M. W. Kellogg Co., New York, 1941.

[2]Piping Stress Calculations Simplified, by S. W. Spielvogel. McGraw-Hill Book Co., Inc., New York; 1943.

### THE AUTHOR

Charles H. Green is an engineer with the consulting firm of Lutz and May, Kansas City, Mo. While attending the University of Michigan in 1940, he enlisted in the Flying Cadets, and subsequently served as Maintenance Officer in various sub-depots until September 1945, when he was discharged from the service with the rank of Captain.

In 1946 and '47 he was a draftsman for Black & Veatch, on general power plant design; and for the past two years has held his present position with Lutz and May. Here he has been responsible for piping layout and stress analysis, specification and report writing, and general power plant design work. In both companies he has worked on design details, and particularly piping, in a number of the recently-built steam stations in the Middle West.

He is author of a handbook on ballistics and aerial gunnery, written in the service; and since his return to civilian life, he has been graduated as BS in Mechanical Engineering from the University of Kansas, carrying on this work simultaneously with his engineering work noted above.

He became interested in pipe stress analysis while at the University of Michigan. Although some account of his flexibility prism concept was published in 1948, in the *Kansas Engineer*, this is the first presentation of it in the national technical press.

Mr. Green is a member of ASME and of several honorary engineering fraternities.

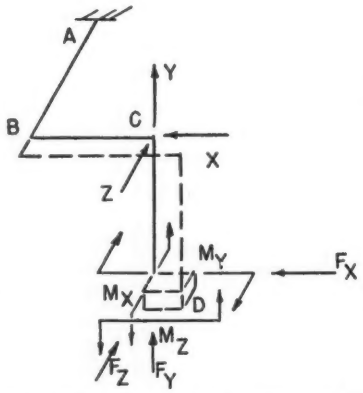



Fig. 2. Diagram of a piping layout to show forces involved in maintaining system in equilibrium. See text

present are all of the simple types that are set forth in any text on strength of materials. The stresses will therefore be listed without development.

1. Pressure stress = $f_{p1}$ = $\dfrac{P \times (D - t)}{4t}$

   Where: P = Fluid pressure in pounds per square inch
   D = Actual outside diameter of the pipe in inches
   t = Wall thickness of the pipe in inches

2. Hoop stress $f_c = \dfrac{P \times (D - t)}{2t}$

   Where the symbols are defined as above

3. Shearing stress = $f_t = \dfrac{M_t}{2S}$

   Where: $M_t$ = the torsional moment and S = the sectional modulus of the pipe cross-section

4. Longitudinal Bending Stress = $f_{b1} = \dfrac{M}{S}$

   Where: M = the bending moment at the point in question and S is the sectional modulus as defined above

These four stresses are combined according to the maximum principal stress theory as follows:

Maximum combined equivalent stress = $S_t$ =

$$\tfrac{1}{2}\left[f_l + f_c - \sqrt{4f_t^2 + (f_l - f_c)^2}\right]$$

Where: $f_l = f_{b1} + f_{p1}$

A close approximation of $S_t$ may be obtained by merely adding the maximum bending stress and the pressure stress: $f_{b1} + f_{p1} = S_t$. Of the above listed stresses, the longitudinal bending stress is of greatest magnitude. Other stresses are present in the structure, but because of their insignificance will be completely disregarded.

### Effect of Bend Radius

Pipe bends used in the figures up to this point have been indicated as square right-angle bends. In actual practice, the radius of the bend will vary from 1.5 pipe diameters to 6 pipe diameters. How does this affect the calculations? Consider the tubular curved beam in Fig. 3. It has been shown that the deflection of point B due to the applied load $F_x$ does not follow the fundamental deflection formula of a straight beam. The deflection proves to be greater and the radius bend is therefore said to be more flexible. The stress in this beam does not follow the beam formula, $S_t = M_c \div I$; but the equation can be made to apply by inserting a stress multiplication factor B derived from the geometrical relationship of the cross-sectional area and the radius of curvature of the pipe bend. The development of the multiplication factor B is beyond the scope of this paper.[3]

The maximum stress of such a curved pipe does not exist at the extreme fiber but at some intermediate point closer to the neutral axis of the section. The cross-section of the tube when loaded changes

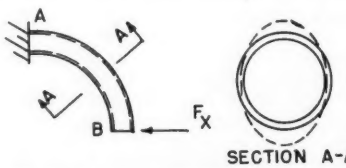



Fig. 3. Diagram showing how cross-section of tube when loaded changes from circle to ellipse.

from a circle to an ellipse as shown in section AA of Fig. 3. The moment of inertia about the axis perpendicular to the plane of the bend is reduced. The bending stress in a radius bend then would be,

$$f_{b1} = (M \times B) \div S$$

Some methods of analysis consider each radius bend of the entire piping layout as an element and determine the maximum stress in the bend by rather laborious methods; however, previous work has shown that comparatively accurate results may be obtained by analyzing the structure as though it were made up of right-angle joints entirely. If the maximum bending moment should occur at a pipe bend, then the bending stress at this point would merely be multiplied by the stress multiplication factor B.

The curved beam discussion would not be complete without mentioning one more recent development. Refer to Fig. 4. Section BB of Fig. 4 shows that the pipe bend is loaded by a force $F_z$ that is perpendicular to the plane of the pipe bend. Until recently it was believed that the deflection of such a beam would follow

[3]Elastic Properties of Curved Tubes by Irwin Vigness, ASME Transactions, Vol. 65, page 119: 1943.

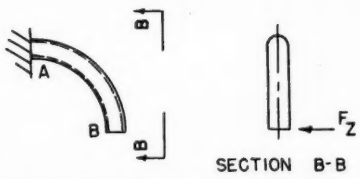



Fig. 4. Diagram of pipe bend loaded by force Fz perpendicular to plane of bend

the straight beam theory; however, it has been shown that the beam does not follow straight beam deflection formulas. Only the most detailed type of analytical solution[3] takes this effect into consideration. The cross-sectional area of such a radius bend under load is changed to an ellipse at a 45-deg angle to the direction of the applied force. This effect on the maximum stress may be neglected unless the total length of pipe is made up primarily of radius bends. Fortunately, in normal piping layouts, the radius bends are a small portion of the total length of pipe.

The ordinary high-temperature high-pressure layout is cold sprung or pre-stressed in order to reduce the maximum stress under operating conditions. This is accomplished by cutting the pipe elements short by one-half of the expected thermal expansion. The elements are then sprung into place.

### Ways of Attacking the Problem

Look now at the general methods of analysis that have been applied to the solution of the problem. A mere listing of some of the possible methods will have to suffice:

1. Grapho-Analytical, based on Area Moments.
2. M. W. Kellogg Co. method using Castigliano's Theorems.
3. Elastic Point Theory.
4. Model Tests.

### Elastic Point Theory

The general application of the Elastic Point Theory will be set forth here without development. Consider Fig. 5. Fix one end at A. Release all restraint at D and permit the pipe to elongate in three dimen-

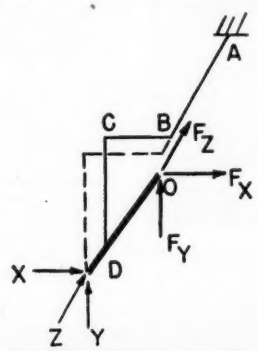



Fig. 5. Piping diagram to illustrate application of Elastic Point Theory. Forces necessary to hold D are found by imagining D set free

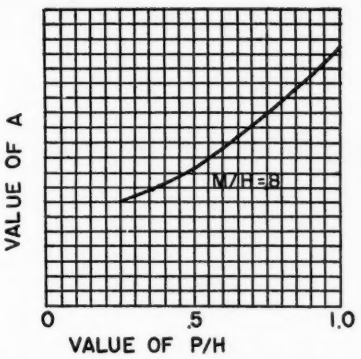



Fig. 6. How Flex-Anal charts are set up to solve problems of type shown in Fig. 7. (Reader must refer to published charts.) When system is as shown in Fig. 7, value of bending stress at A may be read from charts

sions due to its temperature change. Now attach an imaginary, weightless, inelastic bracket to point D and extend it to the center of gravity of the system. Apply three forces $F_x$, $F_y$, $F_z$ at the centroid point O, and cause it to move back to its original position before the expansion took place. The reader will recall the previous analysis of this scheme; there were three unknown moments at the point D. The moments still exist at point D, but no moment is present at point O. The unknowns have been limited to three forces $F_x$, $F_y$, and $F_z$. After determining the reactions, the bending moment and torsional moment at any point in the structure may be found. The bending stress will then be combined with the other stresses present and the maximum combined equivalent stress determined.

In using the Elastic Point Theory, the general solution for the two-anchor, three-dimensional piping problem is indicated as follows:

$$(1)\quad XI_x - YI_{xy} - ZI_{xz} - \triangle XEI = 0$$
$$(2)\quad -XI_{xy} + YI_y - ZI_{yz} - \triangle YEI = 0$$
$$(3)\quad -XI_{xz} - YI_{yz} + ZI_z - \triangle ZEI = 0$$

Where X, Y, and Z represent the unknown reactions in the X, Y, and Z directions, $I_x$ represents the moment of inertia of the entire pipe layout with respect to a gravity axis in the X direction. $I_y$ stands for the moment of inertia with respect to a gravity axis in the Y direction and in the same manner $I_z$ equals the moment of inertia with respect to the Z gravity axis. $I_{xy}$, $I_{xz}$, and $I_{yz}$ represent respectively the product of inertia of the layout with respect to the XY, XZ, and YZ planes. $\triangle X$, $\triangle Y$, and $\triangle Z$ represent the temperature elongations that take place in the X, Y, and Z directions if the end D were allowed to expand freely. E is the modulus of elasticity at operating temperature and I is the moment of inertia of the cross-sectional area of the pipe through the neutral axis.

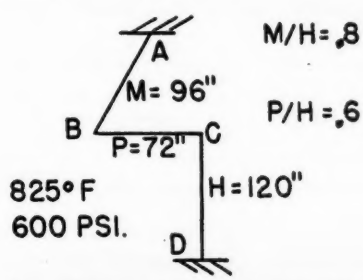



Fig. 7. Diagram of piping system for which bending stresses may be found in published Flex-Anal Charts

No mention has been made up to this point of the possibility of using two different sized pipes in the same layout. It would also be possible to use corrugated pipes and creased pipes instead of the usual straight pipe. These new variables are taken care of by calculating an equivalent length to be used in place of the actual length. Sometimes the anchor that supports one end of the pipe line may have a movement of its own as in the case of a turbine attachment. These variables are considered beyond the scope of this paper. For further reference, consult "Piping Stress Calculations Simplified" by S. W. Spielvogel.

### Application of Grapho-Analytical Charts[4]

A sample problem will now be worked by graphs published by the Blaw-Knox Co. The graphs present the results of calculations obtained from the Grapho-Analytical method. The results obtained for the bending stresses are within ±15% of the correct values obtained by actual calculation. The values obtained from Fig. 6, are for bending stress only. A close approximation of the maximum combined stress may be obtained by adding the bending stress to the pressure stress as previously stated. The solutions were based upon right angle joints and thus do not consider the effect of the radius bend. The scheme will work any problem composed of three elements proceeding as indicated in Fig. 7. The graphs are set up so that element H is always greater than M. All dimensions are in inches. A complete solution of this problem would require the presentation of other curves similar to Fig. 6. The stress calculated here is being determined at point A of Fig. 7. For further information refer to Blaw-Knox Flex-Anal Charts.

Determining the Bending Stress at A:

$$\text{Stress} = \frac{10\ (E \times e)\ (O.D.)\ A}{P}$$

Where $(E \times e)$ is the product of the modulus of elasticity in tension and e the mean coefficient of expansion in inches per inch per degree F, both at the operating temperature of the line. The value of $(E \times e)$ is 135,350 psi from Blaw-Knox. The actual outside diameter of the pipe is 8.625 in. From the values of $\frac{M}{H}$ and $\frac{P}{H}$ shown in Fig. 7 the value of A from Fig. 6, is found to be 0.108. Substituting the values into the above stress formula:

Stress A =

$$\frac{10 \times 135{,}350 \times 8.625 \times 0.108}{72}$$

= 17,500 psi bending stress

Approximate combined stress:

Bending stress plus pressure stress = approximate combined stress

17500 + 2386 = 19,886 psi

The pressure stress was previously determined. A more exact combination of the stresses present would lead to a slightly higher value. This compares favorably with the value of 23350 psi stress that was determined by the Elastic Point method.

### Flexibility Prism Criterion

The two-anchor, three-dimensional problem will now be broken up into simple elements of geometry with the hope that a simple criterion

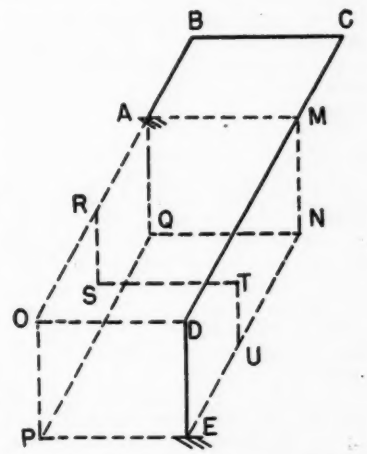



Fig. 8. The flexibility prism as applied to the 2-anchor, 3-dimensional problem

may be established that will aid greatly in the general solution of the problem.

Refer to Fig. 8. Steam is passing from A through B, C, and D, to E as indicated. Consider for a moment all the possible paths that the pipe might have taken in proceeding from A to E.

1. From A through O and D to E.
2. From A through M and D to E.
3. From A through O and P to E.

In general there are several more possibilities similar to paths 1, 2, and 3. Each such path would be along the edges of the rectangular prism A, M, N, Q. O. D, E, and P. It is immediately apparent that any one of these problems could be readily solved by the graph solution indicated above.

4. From A through intermediate points some of which will cause a

[4] Flex-Anal Charts, by Blaw-Knox Co., 1525 Pennsylvania Ave., N. S., Pittsburgh, Pa.

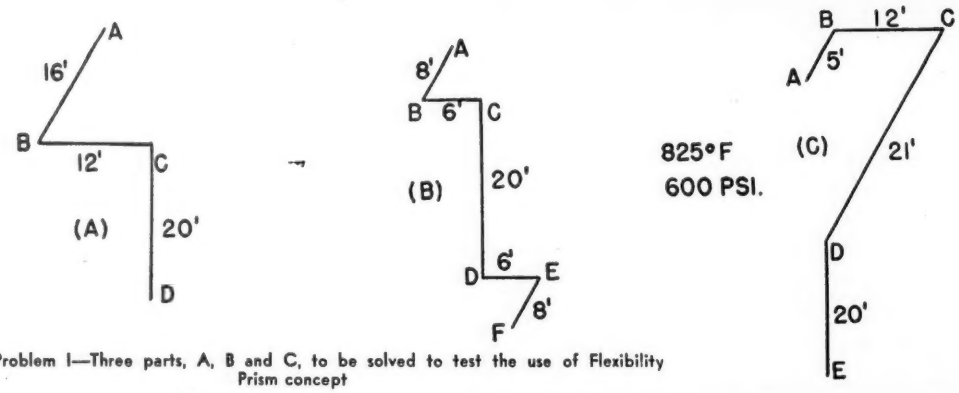



Fig. 9. Problem I—Three parts, A, B and C, to be solved to test the use of Flexibility Prism concept

pipe element to lie inside of the rectangular prism. Hereafter the rectangular prism, referred to above, will be called the Flexibility Prism. It should be noticed that such a path as A through R, S, T, and U to E will in general decrease the moment of inertia of the structure.

5. From A through B, C, and D to E; such a course lies outside of the Flexibility Prism in a part of its path.

6. It would be possible to proceed directly from point A through space to E. In practice this is impractical because of building and equipment details.

Some simple statements may now be set down to be proved:

A. If the pipe passes from A along any path on the edge of the Flexibility Prism, the magnitude of the maximum stress may be calculated by the graphs previously discussed.

B. If the pipe passes inside of the Flexibility Prism, then the magnitude of the resulting stress will be larger than the value obtained in A immediately above.

C. If the pipe passes outside of the Flexibility Prism, but still ends up at E, then the resulting stress will be less than the value obtained in A above.

### Problems Worked Out

The author, in an effort to determine the validity of the general statements A, B, C, worked out a series of problems which are at present considered to indicate that the statements are true. The resu'ts were obtained by using the Elastic Point solution and the graph solution.

Problem I was divided into parts A, B, and C. Figure 9 gives the dimensions and conditions of the problem. The results of the calculations are shown in Table I.

The results are precisely as were expected. The space distance between the end elements did not change in parts A, B, or C. The stress is approximately 8000 psi greater when the pipe passes through the Flexibility Prism. When the pipe passes outside of the Flexibility Prism as in Part C, the stress is decreased by approximately 1100 psi.

The dimensions and operating conditions of Problem II are given in Fig. 10. The resulting data are shown in Table II.

Part A indicated close agreement between the graph solution and the Elastic Point Method. Part B of Problem II clearly demonstrates that the resulting stress is less when the elements pass outside of the Flexibility Prism than when passing along the edges.

There are some details of this interesting subject that have of necessity been covered lightly or left out completely; however, an attempt has been made to highlight those facts that were considered of paramount importance to the engineer in his routine analysis of piping layout problems. It is believed that the Flexibility Prism concept can be a simple valuable tool when applied carefully.

Table I. Results of Problem I Maximum Combined Stress

| | Part A | Part B | Part C |
|---|---|---|---|
| Elastic Point Method | 10500 psi | 19520 psi | 9590 psi |
| Solution by Graphs with aid of Flexibility Prism | 11300 psi | Must be greater than 11300 psi | Must be less than 11300 psi |

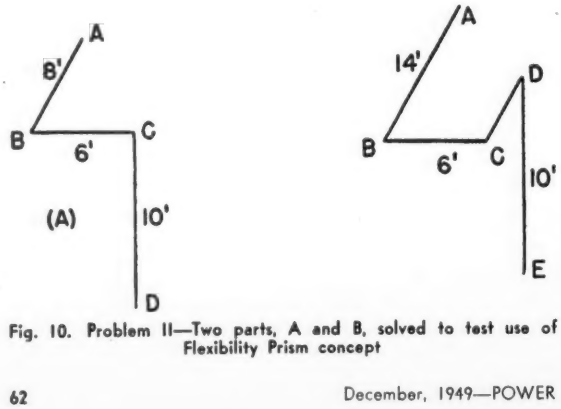



Fig. 10. Problem II—Two parts, A and B, solved to test use of Flexibility Prism concept

Table II. Results of Problem II Maximum Combined Stress

| | Part A | Part B |
|---|---|---|
| Elastic Point Method | 23354 psi | 10494 psi |
| Solution by graphs with aid of Flexibility Prism | 20100 psi | Predicted stress less than 20100 psi |

# Chart Simplifies Fuel Purchasing

**Here is a chart which with little effort will enable you to determine the comparative value of different fuels when used in furnaces having different combustion efficiencies**

By **TYLER G. HICKS**, Mechanical Engineer, Summit, N. Y.

FREQUENTLY, during fuel purchasing, it is desirable to compare costs of the various types available. Longhand or machine calculations, while satisfactory, consume much time because monetary and heat unit conversions are usually necessary. The accompanying chart permits quick estimates of purchasing and utilization costs for the four most common fuels; coal, oil, gas, and electricity. Results obtainable by use of the chart are sufficiently accurate for all common purchasing problems. Its use is as follows.

EXAMPLE 1: Coal with a heating value of 10,000 Btu per lb costs $8.00 per ton. What is the purchased cost per million Btu supplied by this coal? If the coal is burned in a heater with a combustion efficiency of 50 per cent, what is the cost per million Btu utilized?

SOLUTION: Enter the chart at 10,000 Btu per lb heating value on the left, scale A, and draw a line through $8.00 per ton on scale B. Project this line to scale C and read $0.40 per million Btu, purchased cost. From the point on scale C, ($0.40), draw a line through 50 per cent combustion efficiency, scale D. At the intersection with scale E, read the utilized cost as $0.80 per million Btu.

This example shows that although the fuel costs only $0.40 per million Btu when purchased, combustion losses increase the cost to $0.80 per million Btu.

EXAMPLE 2: The costs determined in Example 1 have been approved as satisfactory by plant management. However, 150,000 Btu per gal fuel oil is also available for use. Since handling oil is simpler than coal, the plant management wishes to know what unit price should be paid for oil in order not to have oil costs exceed those of coal. Oil combustion efficiency is 85 per cent.

SOLUTION: The cost of the heat utilized should be equal for both coal and oil. Hence, starting from $0.80 on scale E, draw a line through 85 per cent combustion efficiency, scale D, and prolong it to scale C. Then draw a line from this point on scale C to 150,000 Btu per gal on scale A. At the intersection with the fuel price, scale B, read $0.10 per gallon. Thus, 10 cents per gallon oil burned at 85 per cent combustion efficiency equals $8.00 per ton coal burned at 50 per cent combustion efficiency.

These are two of the more common purchasing problems which can be solved by use of this chart. In cases where the utilized cost of two fuels appears to be equal, a longhand or machine check is necessary to determine the exact cost accurate to two or three decimal places. Fuel heating values and combustion efficiencies for use in the chart can be obtained from the plant engineer or fuel dealer.

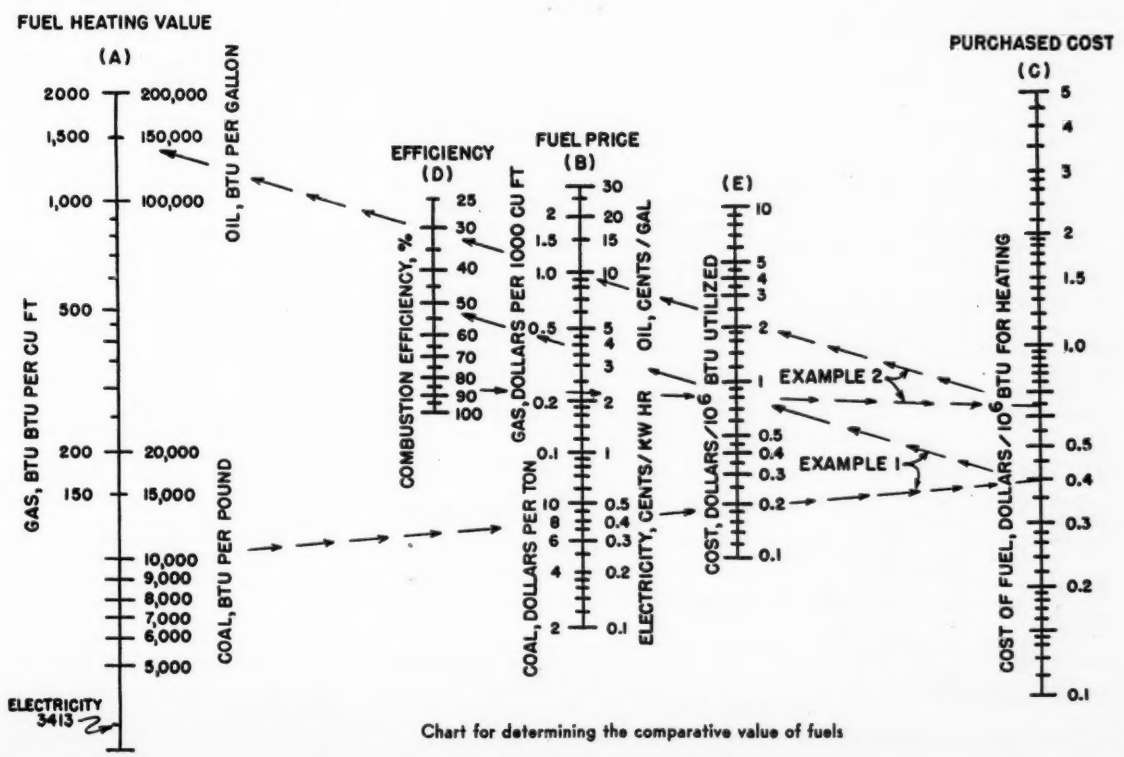



Chart for determining the comparative value of fuels

# Power Supply Affects Choice of Mine Hoist Drive

**While this article is primarily concerned with a discussion of the effect of mine hoist drives, it applies also to other types of electric drives involving large motors. In the selection of these drives it is not sufficient to base the selection on the requirements of the load but the characteristics of the power system itself must be considered. These drives draw so much current at various times of the duty cycle that unless proper consideration is given, their operation may seriously affect the stability of the power system supplying the energy. In this article Mr. Rich analyzes the performance of such drives and shows how to attack problems of this kind**

**By E. A. RICH**
Mining Division, Industrial Engineering Divisions,
General Electric Company, Schenectady, N. Y.

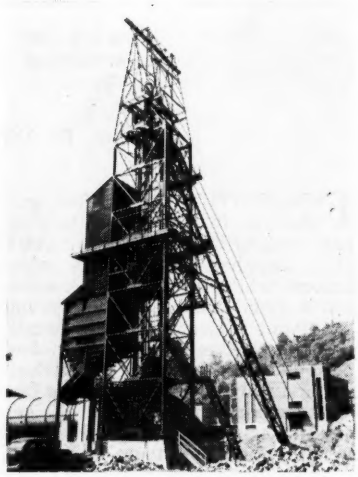


Fig. 1. Typical Mine Hoist

THE SELECTION of certain types of electric drives is often dependent upon the characteristics of the power system to which the drive is connected. Mine hoist drives are drives of this type. Mine hoists are frequently located at considerable distances from the power supply source and before a drive for such hoists are decided upon certain factors should be analyzed. The two most important are as follows:

1. What are the effects of applying a mine hoist duty cycle on a power supply system?

2. Interpreting these effects in terms of the type of hoist drive to apply and possible power supply modifications necessary to satisfactorily supply the hoist.

Other factors also enter but these are the most important.

### Types of Mine Hoist Drives

In general, there are three usual systems of electric hoist drives. These are:

1. Straight a-c drive using a wound rotor induction motor geared to hoist drum, and with primary leads connected to the source of power through reversing contactors.

2. Adjustable voltage Ward Leonard drive with a synchronous motor-generator set supplying power to the d-c motor actually driving the hoist drum. Speed and direction of the hoist are varied by controlling the d-c generator field current.

3. Adjustable voltage Ilgner-Ward Leonard drive with an induction motor driven flywheel type motor-generator set using a liquid slip regulator in the secondary of the induction motor. Otherwise the d-c portion is as described in system No. 2 above. The purpose of the flywheel is to smooth out the hoist duty cycle load fluctuations before they are transmitted to the power supply system.

Each of these systems modifies the hoisting duty cycle differently *as seen by the power supply system.* Fig. 3 shows duty cycles for a typical ore hoist in terms of horsepower input from the power supply system to the hoist drive system. The hoist motor is rated 3000 hp. Its shaft output is also shown in Fig. 3.

The differences in ordinates between curves 1 and 2, 1 and 3, or 1 and 4 of Fig. 3 represent the power consumed as losses in the hoist electrical system itself for the particular hoist system represented by curves 2, 3 or 4.

Integrating, or adding up, the respective areas under curves 2, 3 and 4 gives the total energy-in horsepower seconds-consumed per hoisting trip for each system. By subtracting the integrated area under curve 1 from each of these curves, the energy losses — hence overall hoisting efficiency—for each hoisting system are derived.

### Effects on Power System

To see just how the various hoisting systems effect the power supply system, an investigation of overall system performance is approached from the following viewpoints.

1. What is the effect of kw peaks on the power generating equipment including prime movers.

2. What are the effects of load changes on system voltage regulation, i.e., what system voltage fluctuation will result from operation of the hoist?

This study becomes essential when a large hoist motor is to be installed on a power system of (a) limited capacity, or (b) the feeder capacity between main system and hoist bus is limited.

### Power Peaks

The power, or kw, peaks, together with the rates at which these peaks are gained and lost, may cause un-

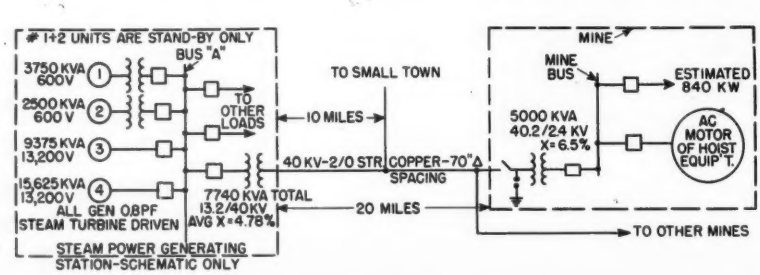



Fig. 2. Simplified one line diagram of system

desirable system frequency swings if prime movers such as steam or hydraulic turbines in the power house are unable, or cannot be regulated sufficiently fast, to keep up with the load changes.

Inadequate prime mover capacity due to inlet nozzle or other, limitations; insufficient steam storage capacity, inertias represented by moving columns of water in the penstock; time to operate valves, etc.; may all contribute to causing objectionable power system frequency swings.

These factors are only mentioned to indicate their existence. As the size of the system becomes larger, the importance of kw load changes becomes less. Fortunately, most systems are becoming larger with time. Since many mines are in relatively isolated locations, the effect of kw load changes on power station frequency must still be considered occasionally.

### Voltage Regulation of Power Supply System

The hoisting duty cycles are seen by the electrical portion of the power supply system in terms of kilowatts and kilovars. These, in turn, cause impedance voltage drops in the system which vary as the load varies. These cyclic system voltage fluctuations may cause objectionable light flicker. If voltage fluctuations are severe operation of other connected loads such as motors, etc., may be adversely affected.

ASA standards specify that rotating machines will operate successfully, though not necessarily in accordance with guarantees, at voltages of plus or minus 10 per cent of normal. The standards for judging voltage fluctuation in terms of effect on light flicker are not so well defined. To help judge this point Fig. 4 is often used by some engineers. Fig. 5 shows a similar curve used by at least one of the large eastern public utilities.

A point to remember about light flicker is that for a given amount of light flicker, people react differently. For the kind of work one is doing also affects the irritability to a given amount of light flicker.

Synchronous motor input current curves, corresponding to curve 3, Fig. 3, are shown in Fig. 6. Also included are curves showing corresponding synchronous motor approximate power factor and reactive KVAR during the duty cycle. Current curves for the other two hoisting systems are not included since they closely follow the shape of curves 2 and 4 of Fig. 3. Power factor of these latter two systems is always lagging.

### Reducing System Voltage Fluctuation With Synchronous Motors

By adjusting the synchronous motor field strength during operation as a function of load, the leading component of current resulting

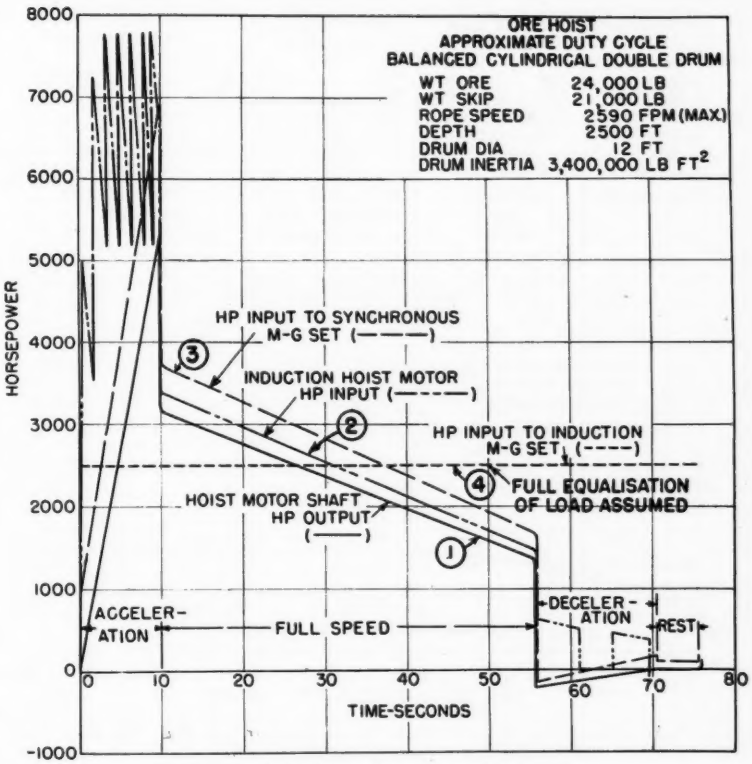



Fig. 3. Mine hoist duty cycles in terms of horsepower

can then be used to help offset usual current-impedance voltage drops in the power supply system.

If the synchronous motor excitation is not adjusted as a function of load, but held at a constant (say rated) value, the leading current drawn by the motor would actually cause a rise in system voltage with the hoist at rest. At peak loads, the power factor of the motor might be lagging which would cause a drop in system voltage. The voltage may therefore still fluctuate extensively during each hoisting cycle.

For the particular example cited, the field current is varied as a function of kw load by means of a five-step automatic field regulating equipment. This field regulating equipment consists of four watt-sensitive power directional relays, each of which closes (or opens) its contacts at a predetermined value of syn-

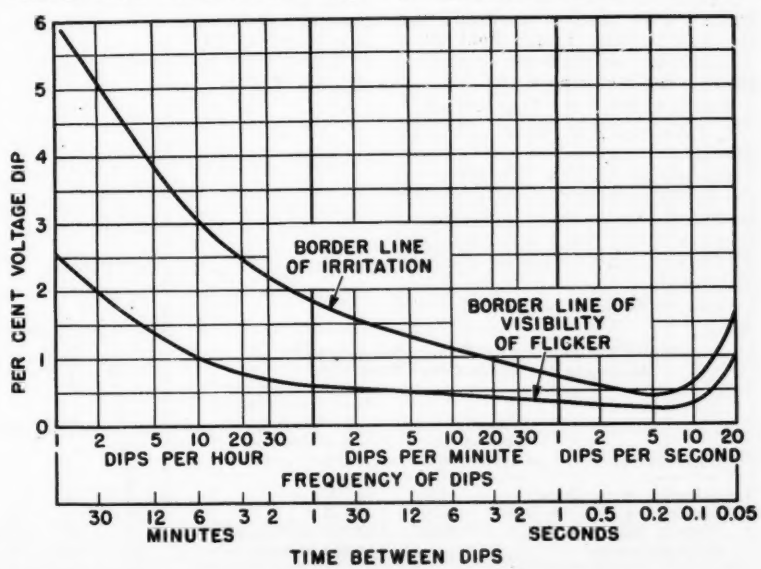



Fig. 4. Flicker of incandescent lamps caused by recurrent voltage dips. This chart often used by some engineers

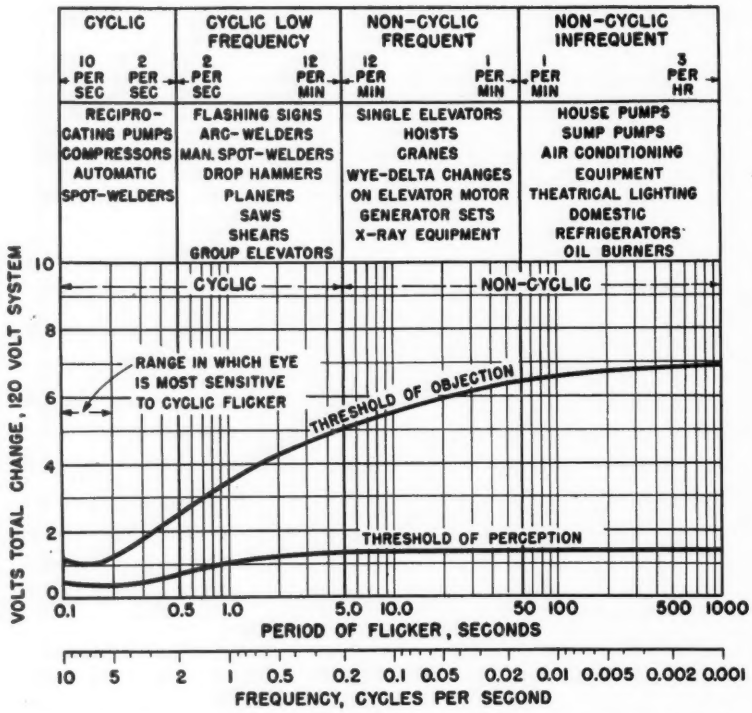



Fig. 5. Flicker of incandescent lamps caused by recurrent voltage dips. This chart published in 1937 by a large Eastern Utility Co.

chronous motor input watts. These relay contacts, in turn, cause individual contactors in the field circuit to operate in such a way as to short out (or insert) blocks of resistance in series with the field winding.

An additional power directional relay is included to automatically reverse the potential coils of the other four relays should the hoist load overhaul the motor, causing the motor to act as a generator.

Another somewhat more expensive but stepless, method of regulating the synchronous motor field as a function of load uses an amplidyne type power-factor regulator.

**Results of Study For Sample Hoist**

1. Effect of KW Peaks on Power House

The steam turbine generators in the powerhouse of the system shown in Fig. 2 are normally operated so that No. 3 and No. 4 units, totalling 20,000 kw capacity, are on the line. The maximum kw which the power station can deliver (at normal steam pressure) is limited by the size of the turbine inlet nozzles to 8 per cent overload, or 21,600 kw. Taking into consideration the efficiency of the power supply system, the accompanying table shows effects of hoist loads on maximum kw available to supply loads other than the 3000 hp hoist drive for the three different hoisting systems considered.

Should the total of the other loads, when combined with the hoist peaks, exceed the 21,600 kw maximum station rating, the system frequency will drop while the excess overload lasts.

For the example cited, the maximum turbine kw rating could be increased to 20 per cent over 20,000 kw or 24,000 kw, by replacing present inlet nozzles with larger ones. This relatively inexpensive change would considerably increase the maximum kw of generating capacity available for loads other than the hoist, assuming an adequate steam supply. The assumption of adequate steam supply would of course, have to be checked and confirmed with the steam system designers before making turbine changes to obtain higher short time kw load capacity.

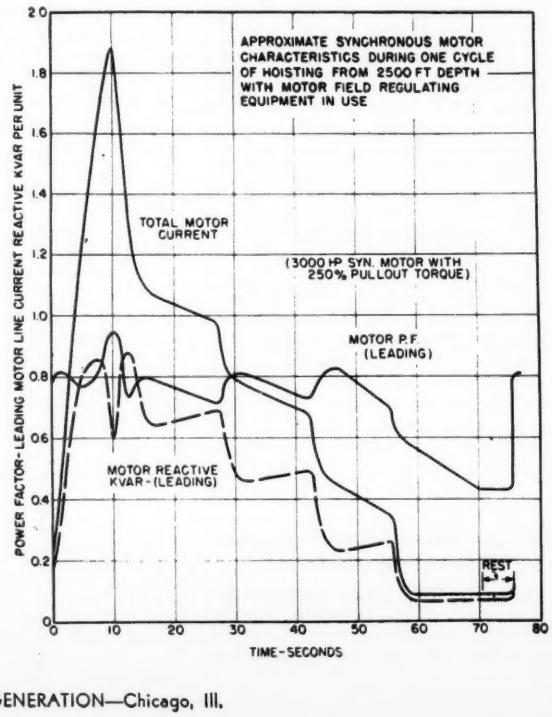
The kw capacity required to handle hoisting peaks for the straight induction motor and synchronous m-g set drives, ties up more than sufficient kva of generator capacity necessary to avoid excessive heating of the generators due to additional hoist load. The reason for this is that the heating effect on generators is mostly determined on an rms basis during operation, while the kw capacity required is selected based on peak kw demand during the cycle.

2. System Voltage Fluctuation

Figure 7 shows comparative voltage fluctuations throughout the power supply system for each of the three systems of hoisting. The effects of the loads of the small town and other mines have not been included in Fig. 7.

At first thought it might be supposed that the fully equalized flywheel m-g set drive would cause

Fig. 6. Mine hoist duty cycle in terms of input to synchronous motor termina's for synchronous M G set hoisting system




**Hoist KW Demand vs. Generating Capacity Available For Loads Other Than Hoist**

| | Hoisting System | Max. Hoist Kw Demand at Bus A, Fig. 2 | Max. Generating Kw Capacity Available For Other Loads |
|---|---|---|---|
| 1. | Induction Motor Drive | 6500 | 15,100 |
| 2. | Synchronous M-G Set Drive | 5600 | 16,000 |
| 3. | Flywheel M-G Set Drive, Full Equalization | 2200 | 17,800 continuous* 19,400 momentary* |

* Based on 20,000 kw continuous rating of turbo-generator sets; should the other loads be of short duration the momentary capacity shown could be handled.

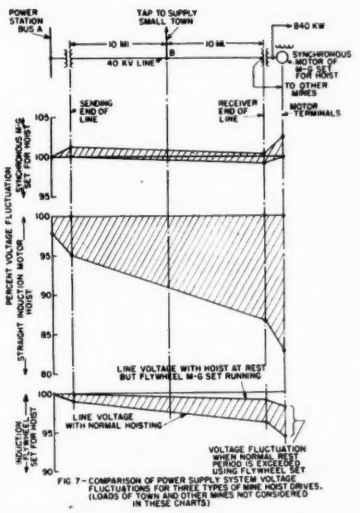

POWER STATION BUS A
TAP TO SUPPLY SMALL TOWN
840 KW
10 MI
10 MI
8
40 KV LINE
SYNCHRONOUS MOTOR OF M-G SET FOR HOIST
TO OTHER MINES
SENDING END OF LINE
RECEIVER END OF LINE
MOTOR TERMINALS
PERCENT VOLTAGE FLUCTUATION
SYNCHRONOUS M-G SET FOR HOIST
STRAIGHT INDUCTION MOTOR HOIST
LINE VOLTAGE WITH HOIST AT REST BUT FLYWHEEL M-G SET RUNNING
LINE VOLTAGE WITH NORMAL HOISTING
INDUCTION MOTOR-FLYWHEEL SET FOR HOIST
VOLTAGE FLUCTUATION WHEN NORMAL REST PERIOD IS EXCEEDED USING FLYWHEEL SET
FIG 7 - COMPARISON OF POWER SUPPLY SYSTEM VOLTAGE FLUCTUATIONS FOR THREE TYPES OF MINE HOIST DRIVES. (LOADS OF TOWN AND OTHER MINES NOT CONSIDERED IN THESE CHARTS)

**Fig. 7. Comparison of power supply system voltage fluctuations for three types of mine hoist drives. Loads of town and other mines not considered in these charts**

no voltage fluctuation during hoisting. This is true if the normal hoisting cycle is maintained continuously. However, should the rest period of the duty cycle be appreciably longer than normal, the induction motor driving the flywheel m-g set will speed up until the power input drops the running light losses of the set. This causes changes in the power supply system voltage drops for these two conditions of operation. Curve 3 of Fig. 7 illustrates these points. Also Fig. 8 is included to show a power input chart to a typical flywheel m-g hoist drive and shows the power changes occurring during such extended rest periods.

By comparing Fig. 7 with Figs. 4 and 5, it is evident, from a light flicker standpoint, that system voltage fluctuations are acceptable to most people for the synchronous m-g set drive. The straight induction motor hoist drive will cause voltage fluctuations which are intolerable from a light flicker standpoint. Neither does this system meet the plus or minus 10 per cent voltage variation allowed by ASA standards.

Voltage fluctuations possible under certain operating conditions of the flywheel m-g set drive are greater than for the synchronous m-g set drive. Probably such voltage changes in terms of light flicker, could be tolerated by many people if they didn't occur too often.

Consideration of the possible effects the power supply system and the type of mine hoist drive have on each other, gives rise to the following conclusions:

1. Larger horsepower hoists may present a serious voltage fluctuation problem if the straight AC induction motor hoist drive is used unless backed up by an adequate power supply system. Possible light flicker, where objectionable, will greatly increase the problem of holding voltage fluctuations to reasonable levels.

2. If the kw load changes during hoisting represent a substantial portion of the power source capacity, undesirable system frequency changes may result.

3. The synchronous m-g set Ward Leonard hoist drive, when equipped with automatic synchronous motor field regulating equipment, can usually be arranged to hold system voltage fluctuations, and light flicker, to tolerable levels. In addition, as extra benefits, the synchronous equipment always costs less and operates at considerably higher hoisting efficiency than does the Ilgner-Ward Leonard equipment.

4. The only reasons for applying a flywheel m-g set with adjustable voltage d-c drive are:

(a) Power generation equipment is inadequate to handle the kw peaks.

(b) For some reason the synchronous motor of the m-g set may not be able to produce enough leading kvar at peak load even with overexcitation to prevent excessive system voltage drop. For new equipments this should occur rarely.

(c) Insistence, or personal preference, of customer (or customer's power company) for flywheel sets. In this connection a few power companies still retain rate penalties for peak kw demand. If the peak demand rate penalty cannot be modified, the way is still open to study the economics of the lower hoisting efficiency together with the higher cost, of the flywheel type of equipment as compared to the penalty for the higher demand drawn by the synchronous equipment. Also the not inconsiderable lagging kvar drawn by the induction motor flywheel m-g set type of equipment, can be brought to the attention of the power company for their economic consideration. The synchronous m-g set can usually be adjusted to maintain a leading PF at all times during normal hoisting.

In cases where the penalty in power rates is for maximum demand integrated over a period of time (and not for instantaneous peak kw demand), the synchronous m-g set drive compares favorably with the induction flywheel m-g set drive.

5. Many power supply systems are adequate to handle straight induction motor mine hoist drives. As systems grow, this will become true more often. In addition, since the straight induction motor hoist drive has lower first cost, inherently great simplicity, ruggedness, and good operating efficiency in many hoist applications, this system is used in the vast majority of cases.

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## ALUMINUM SHEATHED CABLE INTRODUCED IN ENGLAND

ALUMINUM SHEATHED under-ground, over-head, and submarine cables have been introduced successfully in England and Germany, replacing lead-sheathed cable.

This and other new and contemplated uses of aluminum in the electrical field were reported by H. V. Menking of the Reynolds Metals Company at the Cincinnati meeting of the AIEE recently. He said investigations are being made of the possibility of using aluminum wire and cable without steel support for building wire to replace copper.

"This field includes insulated wire for lighting and power circuits in residence and bare or insulated power cables used for many purposes in industrial plants. In view of the expected increasing scarcity of copper, the use of aluminum, not as a substitute for copper but as an alternate material based on its own merits certainly requires close consideration," he said.

Mr. Menking revealed that transmission towers, built from aluminum and rolled or extruded shapes, are under study. He added that use of aluminum wire in industrial hoisting equipment offers attractive possibilities.

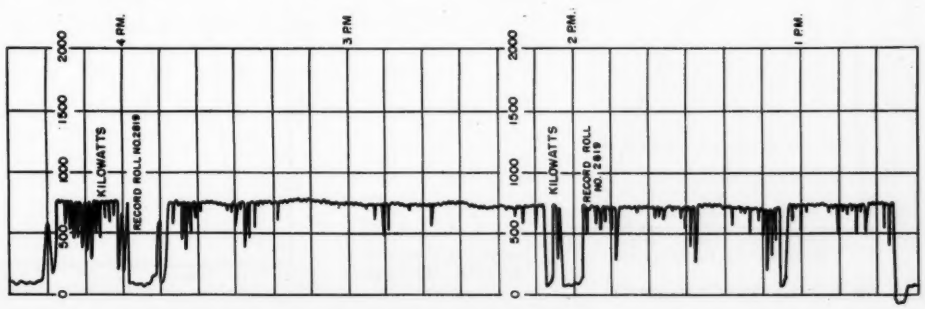



**Fig. 8. Power input record during hoisting for typical induction motor flywheel Type M-G Set**

# Telephone Influence Factor and What to Do About It.

**Telephone circuits are very sensitive to the magnetic fields surrounding conductors carrying alternating currents. The amount of interference set up by such a-c voltages is a function of the frequency, hence it is necessary to keep the harmonic content of the circuits as low as possible. This article which is based upon a paper presented by the author at the Conference of the Petroleum Industry Electrical Association discusses the methods by which the telephone interference factor may be reduced**

By **G. L. OSCARSON** Chief Application Engineer, Electric Machinery Mfg. Co., Minneapolis, Minn.

AN ELECTRICAL engineer once stated that the energy consumed in an incandescent light was sufficient to cause all the telephone receivers in the State to hum. This was probably an exaggeration, but it illustrates forcefully the vast difference in energy level of power and communication circuits. An almost imperceptible wrinkle in a 60 cycle sine wave may cause excessive telephone noise.

Power circuits which parallel telephone lines, or are otherwise inductively coupled to them, may induce voltages, causing currents to flow, which will interfere with transmission and reception of sound energy. This may be described as telephone interference. The quantitative value of the interfering effect of some one power unit, taken individually, or of the power circuit as a whole has been evaluated and may be determined by circuits and meters developed for that purpose.

The first quantitative means of power system interference on telephone lines was established by an AIEE sub-committee on wave standards in 1919[1]. The standard they proposed was known as Telephone Interference Factor and remained in effect until 1935.

In 1935[2] a new standard was adopted. This is known as Telephone Influence Factor, abbreviated to TIF, and has been the basis for all recent measurements. All material in this article is on the basis of the 1935 standards.

A telephone system must transmit a wide range of frequencies, the extreme probably being from 200 to 400 cps. If the higher frequencies are absent, speech would be intelligible but would be lacking in quality. Even if you knew the speaker well you would not recognize the voice. If the lower frequencies are absent the speech would be recognizable but not the words. It would sound like a foreign tongue.

Tests were made by reading news items to various listeners and also by articulation of unrelated syllables while currents of various frequencies, but equal amplitude, were superimposed on the circuit. The relative interfering effects determined from thousands of tests as plotted in curve form are shown in Fig. 1. This shows a peaking effect near 1100 cycles which is approximately the resonant frequency of ordinary telephone receivers and is close to the point of maximum sensitivity of the human ear. It was found that the interference was proportional to the amount of current. It varied widely with the frequency as the curve shows.

It was desired to adjust the values

[1] H. S. Osborne, AIEE Transactions 1919, p. 261-88.
[2] J. M. Barstow, AIEE Transactions, 1935, p. 1307-15.

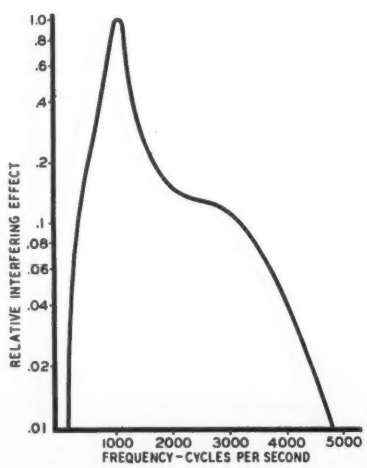
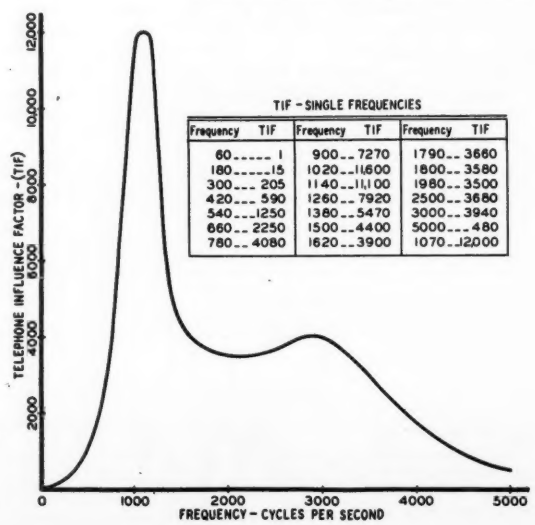



Fig. 1. Interference vs frequency




TIF - SINGLE FREQUENCIES

| Frequency | TIF | Frequency | TIF | Frequency | TIF |
|---|---|---|---|---|---|
| 60 | 1 | 900 | 7270 | 1790 | 3660 |
| 180 | 15 | 1020 | 11600 | 1800 | 3580 |
| 300 | 205 | 1140 | 11100 | 1980 | 3500 |
| 420 | 590 | 1260 | 7920 | 2500 | 3680 |
| 540 | 1250 | 1380 | 5470 | 3000 | 3940 |
| 660 | 2250 | 1500 | 4400 | 5000 | 480 |
| 780 | 4080 | 1620 | 3900 | 1070 | 12000 |

Fig. 2. Frequency weighting characteristics for TIF measurements

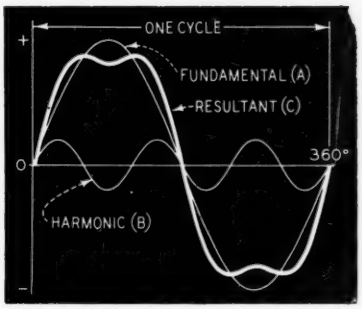



Fig. 3. Fundamental and third harmonic

in Fig. 1, so they would represent the effect of power system harmonics. It was found that the coupling effect on the telephone circuit varied as the frequency. A new series of values was thus obtained by multiplying the interfering effect (from Fig. 1) of each frequency, times the numerical value of the frequency itself. The resultant curve is shown in Fig. 2 and is the present Telephone Influence Factor. It is scaled on the basis that the TIF at 60 cycles equals 1. This curve is thus intended to include probable coupling effect at any given frequency as well as the interfering effect after the harmonic appears in the telephone circuit itself.

The voltage or current wave in each case is assumed to be a true sine wave. The table in Fig. 2 represents the TIF values for various frequencies. Any fundamental 60 cycle wave which is not a true sine wave with a TIF of 1 may be resolved into a 60 cycle sine wave with one or more harmonics (such as a 3rd, a 5th, or higher value) superimposed on it.

Figure 3 illustrates a 60 cycle sine wave with a 3rd harmonic having an amplitude of 20 per cent of the fundamental. It can be shown that the TIF for such a wave would be approximately 3.15.

Figure 4 illustrates a 60 cycle fundamental with a 19th harmonic having an amplitude of 10 per cent. Due to this frequency being close to the peak of the TIF curve the resultant (harmonic superimposed on the fundamental) would have a TIF of 1110.

It is obvious that the harmonics on the power system will probably be present both in voltage wave and the current wave. For convenience measurement is usually made at the generator terminals of open circuit no-load voltage TIF. The effect of adding load to the generator is usually to reduce the open circuit TIF. However, adding capacitors to a system for power factor correction accentuates the higher harmonics and usually increases the TIF at the generator terminals.

Obviously as far as magnetic induction is concerned the product of current times TIF is a measure of the interfering effect. A generator with an operating current of 200 amp and a TIF of 20 will cause twice as much interference in a given location as a unit carrying 100 amp and having a TIF of 20.

The source of Telephone Interference is not limited to generators. It may arise in synchronous or induction motors and may be accentuated by capacitors.

One of the worst cases of telephone interference encountered by one investigator for the Telephone Company was caused by a low speed, slip ring induction motor coupled to a flour mill line shaft. The actual interfering effect of any one machine is in proportion to the current it supplies to (or draws from) the line. In general the TIF on any circuit will be better than that of the worst unit.

Summarizing we might say that the TIF of any unit is proportional to its interfering effect on a telephone system compared to the relative interfering effect of a 60 cycle pure sine wave of the same effective value.

### Measuring TIF

The circuit for one type of TIF meter is illustrated in Fig. 5. The circuit constants are so selected that the admittance to flow of current at various frequencies follows Fig. 2 above. The meter is a thermocouple type d-c milliameter. Usually the terminals are connected through a potential transformer as shown to the circuit under test. Readings are taken in volts and micro-amperes.

$$\text{Quantitatively } TIF = \frac{\text{micro-amps.}}{\text{volts}}$$

This arrangement is used to measure voltage TIF either at no-load or under load. To read current TIF a current coupler is used.

Many noise meters are now provided with resonant networks designed for TIF reading and may be used to measure voltage or current TIF. An analyzer can be attached to the noise meter circuit, permitting readings of the amplitude of all harmonics present.

The important TIFs on synchronous machines or motors are the balanced TIF and the residual TIF.

On the ungrounded-star or on a delta connected generator, the open circuit, no load TIF, measured terminal to terminal is the balanced TIF. The possible components are the non-triple odd harmonics such as the 5th, 7th, 11th, etc. Within the machine itself triple harmonics such as 3rd, 9th, 15th, etc., may circulate in a delta connection but do not appear external to the machine. The algebraic sum of the 3 phase voltages and currents at any instant is zero with respect to earth. The TIF resulting from the non-triple harmonics which appear is known as the balanced TIF.

Present NEMA standards on balanced TIF are as follows:

| *KVA* | *TIF* |
|---|---|
| 62.5 —299 | 300 |
| 300 —699 | 200 |
| 700 —999 | 150 |
| 1000—2499 | 125 |
| 2500—9999 | 60 |

However, if a machine is operated grounded neutral the triple harmonics 3rd, 9th, 15th, etc. will appear at the load and return via the ground lead. Since the triple harmonics in all three phases are themselves in phase they are not balanced out and a residual component will flow. Star connected transformer banks may also set up residual currents due to variation in iron permeability. An extreme example of residual current with respect to earth would be a single phase traction system with overhead trolley and ground return. Such a system is 100 per cent unbalanced and all currents and voltages are residual.

To measure the residual TIF of a machine, it is connected delta with one corner open as per Fig. 6. The TIF meter is connected across the open terminals through a voltage coupler and full terminal-to-neutral voltage is generated and measured by voltmeter V. One third of the current in micro-amperes as measured by the TIF meter divided by terminal-to-neutral voltage is the residual TIF. The voltage across the open terminals may vary from about 0 to 10 per cent of the voltage "V". This voltage is proportional to the magnitude of the triple harmonics circulating in the delta. On a machine wound ⅔ pitch the residual TIF could theoretically be zero. NEMA standards on residual TIF are:

| *KVA* | *TIF* |
|---|---|
| 62.5—299 | 180 |
| 300 —699 | 120 |
| 700 —999 | 90 |
| 1000 —2499 | 75 |
| 2500 —9999 | 30 |

Actually communications engineers are quite consistently insisting on residual TIFs of not over 2.5 on generators to be operated grounded neutral.

### Machine Characteristics Affecting TIF

The harmonics which are superimposed on the 60 cycle fundamental

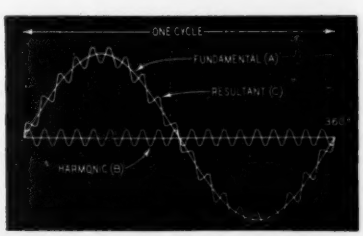



Fig. 4. Fundamental and 19th harmonic

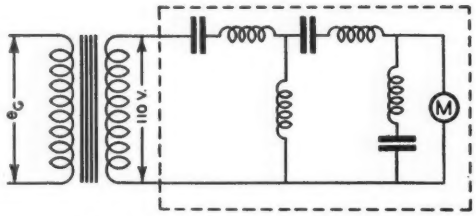



Fig. 5. Circuit for one type of TIF meter

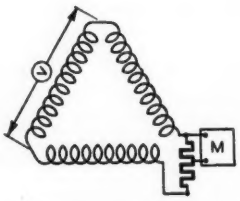



Fig. 6. Measuring residual TIF

are caused primarily by stator slots. On two pole generators the rotor slotting will also be an important factor. Salient pole machines with amortisseur windings may be productive of high TIF values depending on damper bar spacing. Pole shape, coil pitch, saturation and air gap are all important contributing factors to TIF.

On two pole turbine generators the large air gap helps smooth out flux irregularities and keeps the TIF value low. Undesirable combinations of rotor and stator are avoided.

### How TIF May be Reduced

The following studies all deal with a 40 kva, 1200 rpm, 120/240 volt, 3 wire, single phase generator. It had a pronounced 23rd harmonic, having an amplitude of about 15 per cent of the fundamental and an open circuit TIF of about 750. Figure 7 represents the voltage wave with a unity P.F. load of 56 amperes, approximately ½ of full load.

In attempting to reduce the harmonic content various types of filters were applied. The first type of filter applied (Filter No. 1) is shown in Fig. 14. It consists of 4—120 MFD condensers and an iron core reactor which could be switched on in succession.

No TIF meter was available to make quantitative readings. However, a small, poorly filtered radio was plugged into a 120 volt circuit. The radio volume control was held at a fixed point and the radio was detuned from any local station. The only sound from the radio speaker was that due to hum originating in the power supply. The audible hum was nearly proportional to the amplitude of the harmonic and this together with visual inspection of the oscillograms was the only quantitative information obtained. The different filter combinations for filter 1 and the results are tabulated below:

| *Fig.* | *Filter* | *Load* | *Comments* |
|---|---|---|---|
| 7 | None | 56 | Hum audible at 6 ft |
| 8 | 120 MFD | 56 | Hum audible at 6 ft |
| 9 | 240 MFD | 56 | Objectionable hum 0.5 ft |
| 10 | 360 MFD | 56 | Noticeable hum 0.5 ft |
| 11 | 480 MFD | 56 | Faint hum 0.5 ft |
| 12 | {480 MFD {iron core | 56 | Faint hum 0.5 ft |

This is a "brute strength" type of filter, fairly effective over a wide range of frequencies but if the power factor is already high it actually adds to the fundamental current on the generator. The iron core reactor introduces a pronounced 3rd harmonic in Fig. 12. It is not a desirable type of filter.

To avoid the excessive armature current caused by a filter No. 1, a series resonant filter a shown in Fig. 14 was applied.

The wave shape and hum was quite comparable to Fig. 11 using filter type 1. However, the increase in fundamental current due to the filter was only about 25 per cent as much as was caused by that circuit.

Series reactance was added to the filter in Fig. 15. The reactor was of the air core type and the hum was just audible as it was in Fig. 14. Since no improvement was noted and since an extra loss existed in the series capacitor, this type of filter was not used.

A tuned unit as shown in Fig. 16, consisting of a capacitor in parallel with a reactor, was connected in series with the load to determine its effect. The results are as follows:

| *Load* | *Comments* |
|---|---|
| 0 | Audible hum at 6 ft |
| 36 | Appreciable hum at 0.5 ft |

With a filter of this type harmonic voltage divides across the filter and across the load in proportion to their respective impedances. At light load this type of filter is not very effective as the impedance across the load itself is quite high.

If the load impedance for the harmonic is made sufficiently low, the series tuned filter (Fig. 16) would be effective under all load conditions. This can be accomplished by providing a filter as shown in Fig. 17 which adds a tuned shunt filter to the series filter in Fig. 16. This tuned shunt filter provides an effective short circuit for the harmonics. The load impedance for the harmonics is thus very low and most of the harmonic voltage appears across the series filter. The observed conditions on this filter were as follows:

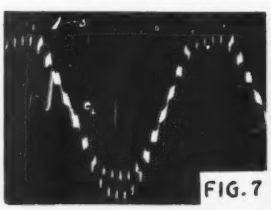
were as follows:

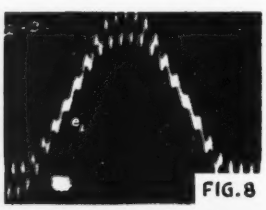
| *Load* | *Comments* |
|---|---|
| 0 | No observable hum at 0.5 ft |
| 46 | No observable hum at 0.5 ft |

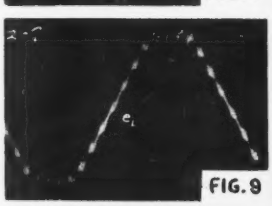
### Summary

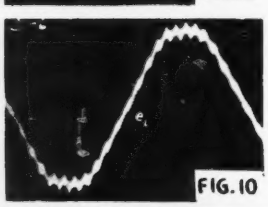
From the above we may draw the following conclusions:

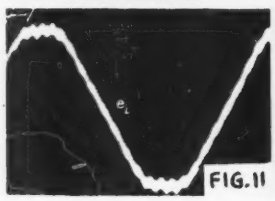
1. The actual amplitude of harmonic required to cause considerable telephone interference may be quite low. For instance, a 1 per cent harmonic at 1020 cycles (17th harmonic) will cause a TIF of 116.
2. TIF alone is not the entire criterion as the amount of interference which can be expected. Whether telephone line is metallic or grounded, and whether power system operates 3 phase grounded neutral will have important results. Inductive exposure, such as long



Figs. 7 to 12. Oscillograms showing effect of various filters on harmonic content of wave

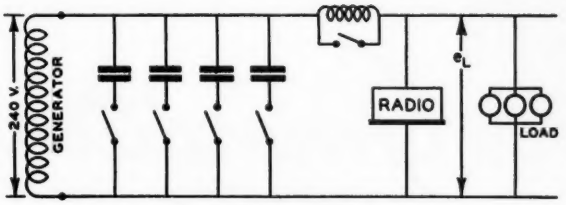



Fig. 13. Filter circuit No. 1

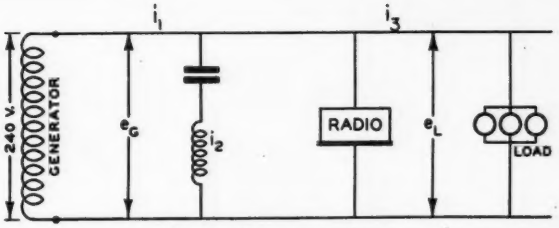



Fig. 14. Filter circuit No. 2

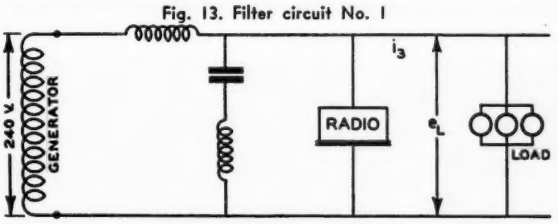



Fig. 15. Filter circuit No. 3

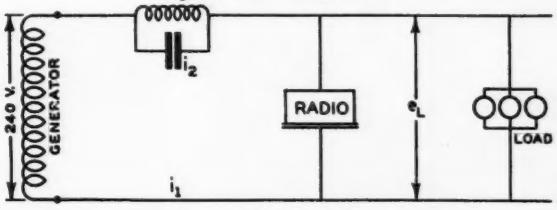



Fig. 16. Filter circuit No. 4

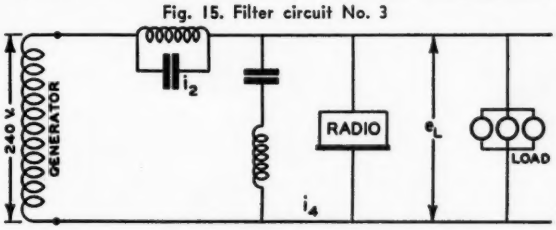



Fig. 17. Filter circuit No. 5

parallel lines, and effectiveness of line transportation are also important.

3. Motors or generators may be equally important in producing telephone interference. The effect of any unit is proportional to its TIF and to its proportional current compared on that part of the system influencing the telephone lines.

4. Harmonic content may be quite effectively controlled in the design of rotating electrical equipment.

5. Harmonics may be effectively removed by providing a "short-circuiting" low impedance path from terminal to terminal, for the higher harmonics.

6. A tuned filter is most effective in removing harmonics without impairing generator performance.

7. A tuned filter is quite selective as to the frequencies it will eliminate.

8. The most effective filter has a series tuned unit and a parallel tuned filter. Such a filter is quite selective also.

9. Where various interfering harmonics are present a "brute strength" type filter as shown in Fig. 13 might be necessary.

# LETTERS

## TO THE EDITORS

*(Continued from page 53)*

has some comments about a serious effort in Great Britain to investigate wind power development with a 60 foot mill and a 100 kw generator. Percy St. Thomas, just retired from the Federal Power Commission, seems to have devoted much time to this method of power production, and suggests wind generators on towers some 400 ft high. How the vagaries and diversity will be overcome is summed up in a statement about Diesel auxiliary units.

Personally I have a preference for some method making the possible use, when needed, of wind power with water storage. There are many locations throughout the country where water storage of this type could be made available. For example, as close to New York City as Staten Island, there are areas 300 ft more above sea level where even salt water from the ocean could be pumped and stored and utilized when needed. Since our only means of storing energy in great volume from natural sources is in the form of water, and the one most readily available, this method should be given more consideration than it is. Pumped storage by excess steam capacity would also be worthwhile in certain cases.

Of course, while coal and oil are still available in large quantities and at reasonably low prices, it is unlikely that these schemes will be given any commercial consideration, but it certainly is worthwhile to think about them as an insurance against future eventualities.

C. O. VON DANNENBERG

## HUEY STATION GAS TURBINE

*(Continued from page 56)*

sor through a precooler erected on the south side of the building. Figure 5. Water from one of the deep wells, supplying make-up water for the steam turbine units in the station, is pumped through this intake air cooler, using discarded generator air coolers for heat exchangers.

The air is filtered by a sectional dry, cleanable type air filter. The filter and precooler also help reduce air intake noise.

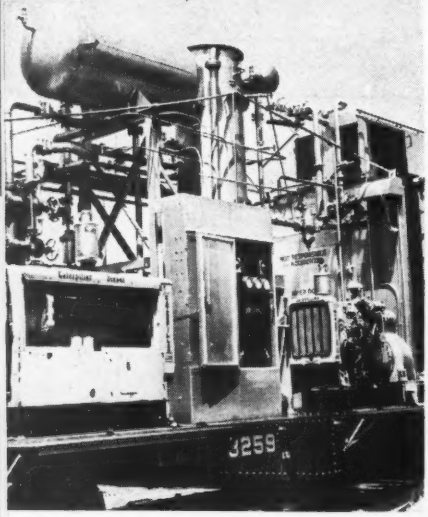
The air precooler lowers the temperature of the inlet air an average of 10 to 20 F and the design calculations show that this raises the turbine output about 500 kw at ambient air temperatures above 60.

Exhaust gas from the turbine passes through a specially designed Combustion Engineering recuperator or heat exchanger of 18,950 sq ft. It is made up of continuous multiple-loop finned tubes. This heats feedwater in the regenerative feedwater heating cycle of the two existing steam turbines in the Huey Station, thus allowing steam previously extracted for feedwater heating to pass farther through the steam turbines and thus generate more power in them. This accounts for the additional kilowatts generated, Table I, above those produced by the gas turbine.

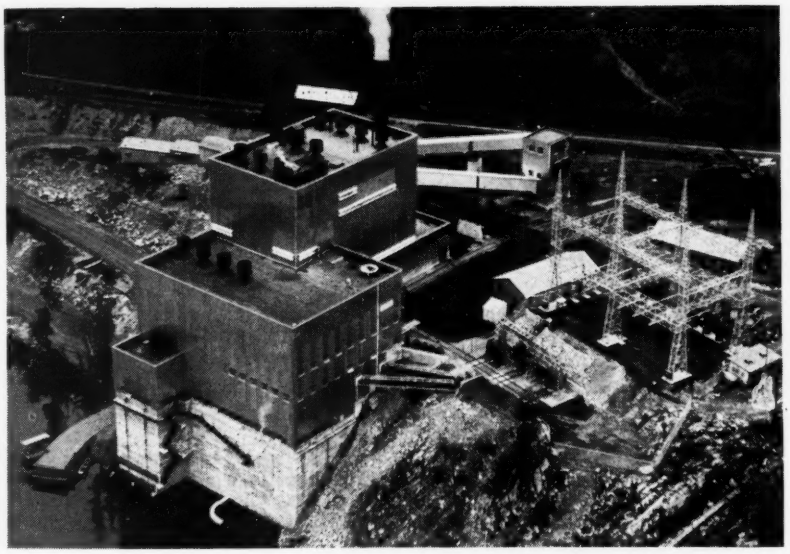
The feedwater is heated by simply looping the boiler feedwater header through the recuperator. The gas temperature to the stack, following the recuperator, is shown on Table I.

The gas turbine power plant for the Huey Station was designed under the supervision of Pioneer Service & Engineering Co. of Chicago, the General Electric Co. and the Oklahoma Gas & Electric Co., of which Otis Howard is manager of operations.

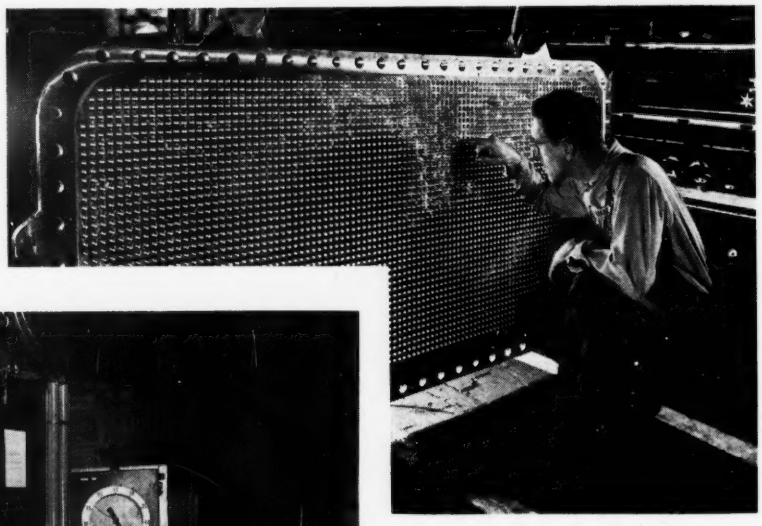
# Power Generation



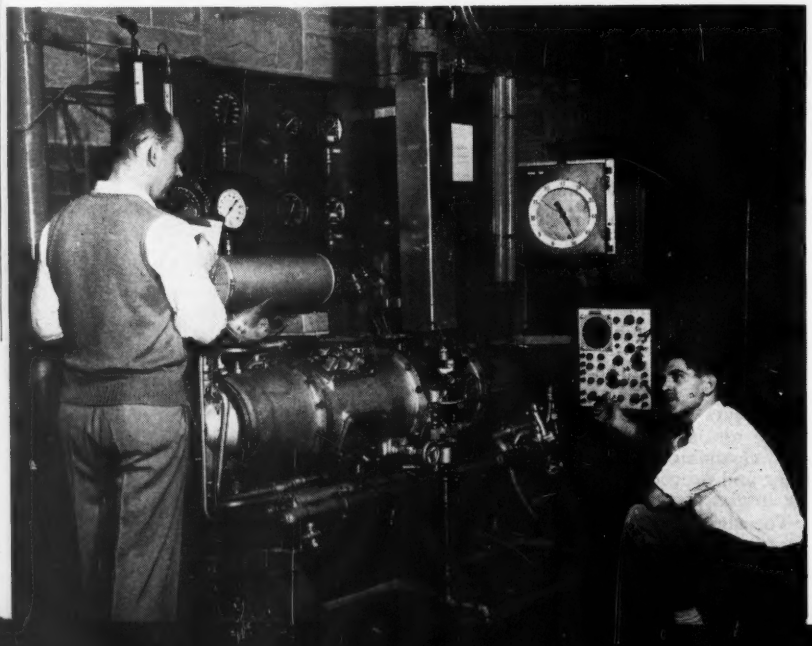

Haas Ice and Cold Storage Co. of Neosho, Missouri, has designed this new mobile ice factory for servicing railway refrigeration cars. Power is supplied by two Caterpillar Diesel engines



Upper right:—Riverton Power Station of the Potomac Edison Co., on Shenandoah River just above Front Royal, Va., dedicated October 28, 1949. Contains one 40,000-kw, 3600-rpm 13,800-v steam turbine generator, supplied with steam at 850 psi, 900 F by a single pulverized-coal-fired boiler. All electrical and mechanical controls of major equipment centralized in one control room. At right are switchyard and towers for 132-kv transmission system. Plant uses 1,800,000 gph of condenser circulating water from Shenandoah River. Coal received by rail and truck. Plant construction by Sanderson and Porter.



Lower Right:—Engineer inspecting regenerator tube sheet for gas turbine locomotive. Allis-Chalmers Mfg. Co. photo

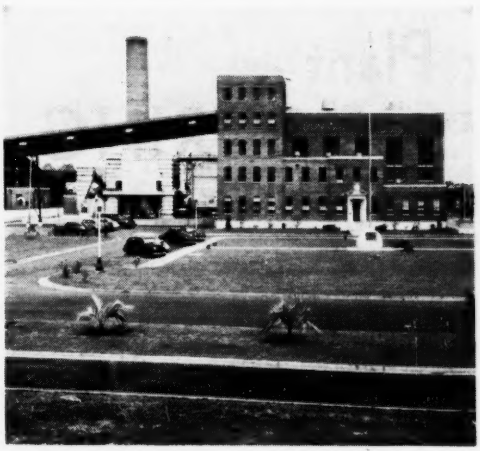


Left:—This German-developed Junkers "free piston" Diesel may offer engineering answers to the problem of how to develop a turbine engine for automobiles or trucks. Pictured here in the Stanford Mechanical Engineering Department laboratory is an air compressor formerly used in a German submarine, but the engine can also be designed as a power gas generator for a turbine.

Engine shown here is a single-cylinder 40-hp unit compressing 70 cfm of free air to 3000 hp. It produces hot exhaust gases at about 100 psi, which will drive a gas turbine.

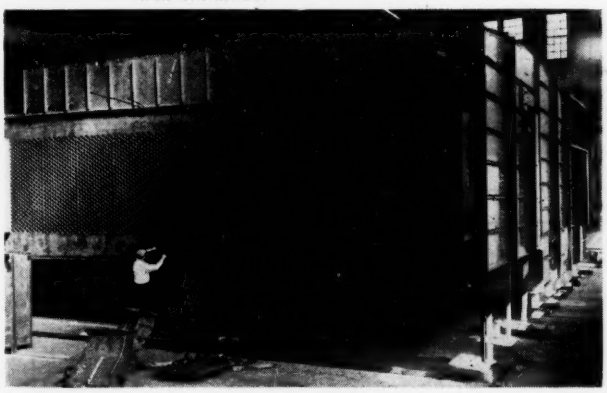
For details of free piston machine and principles of operation, see Free-Piston Engines and Compressors, by Chester R. Earle, *Power Plant Engineering*, April, 1946.

# NEWS REEL

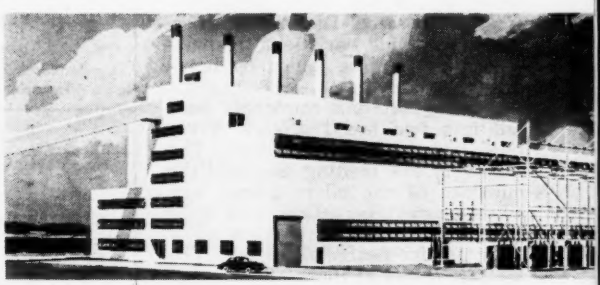


Plant Mitchell, of Georgia Power Co., now in operation at Albany, Ga., first large modern steam-electric plant in South Georgia and first to be built by the company with outdoor boilers, shown at left. Photo: Ingalls Iron Works Co.

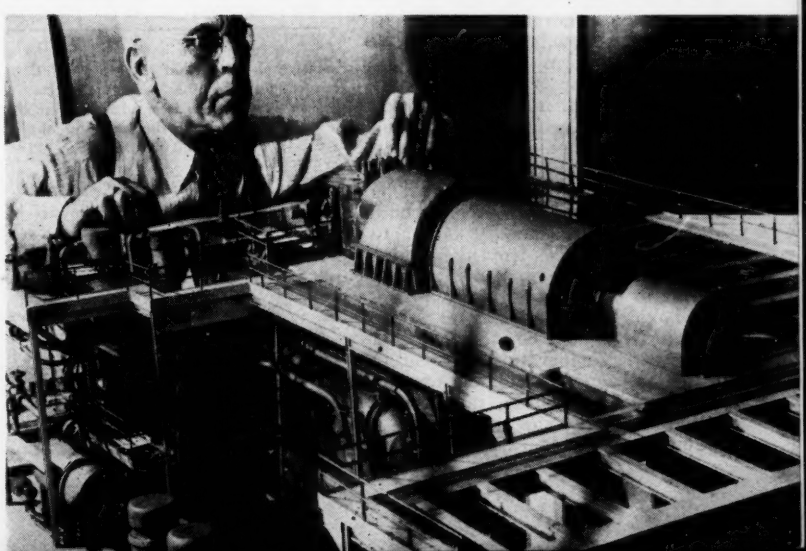
Andrew Willgoos Turbine Laboratory of Pratt & Whitney Aircraft; windowless, 6-story, 400 ft long, 166 ft wide; nearing completion on Connecticut River at East Hartford, Conn. Designed for testing experimental jet aircraft engines. Albert Kahn Associated Architects and Engineers, architect; Burns & Roe, Inc., engineering consultants; Turner Construction Co., contractors



Above:—More than 30 miles of 2½-in. steel tubing have gone into the giant air heater shown under construction in the Chattanooga, Tenn., shops of Combustion Engineering-Superheater, Inc. The weight of this tubular-type air heater for the Central Arizona Power & Light Co., Phoenix, is 45 tons, and it is 17 ft deep, 32 ft wide and 52 ft high. Total effective heat-transfer area for its 3550 tubes is nearly 105,000 sq ft. When completed it will form part of an outdoor steam generating unit having a capacity of 675,000 lb of steam per hour at 920 psig and 905 F total temperature



Construction of a $1,000,000 steam power plant of 18,000 kw capacity for the Dairyland Power Cooperative at Cassville, Wis., is moving along at a rapid pace with excavation and foundation work completed in October, according to its constructors, F. H. McGraw & Co. of Hartford, New York and Chicago.



Right:—When we first saw this picture, we thought of shoveling in the old corn and calling it "Artist and Model." But somebody beat us to it by dubbing it "Dollhouse Engineering." The finished plant, however, will be anything but a dollhouse—looks to us like pretty rugged "big stuff," even in the model.

This model of a turbine room was prepared by General Electric for a large Eastern power company. Howard Chesebro, shown with it, took four months to build it.

## BRAZING

THE CURRENT HANDBOOK of the American Welding Society states:

"Brazing is usually defined as a group of metal joining processes wherein the filler metal is a nonferrous metal or alloy whose melting point is higher than 1000 F, but is lower than that of the metals or alloys being joined."

Brazing, unlike welding, does not require that the surfaces of base metals be melted; it differs from soldering, frequently termed soft soldering, in that the latter method makes use of filler metals which melt below 700 F. Some confusion has resulted from the long use of the term "hard soldering" to denote brazing in which the silver alloys which melt from about 1150 to 1600 F are used.

Brazing depends on the limited diffusion of the filler metal into the clean surfaced, hot, solid base metal. This is in contrast with fusion welding in which intermelting of the surfaces of the base metal and the filler metal takes place to form an integral joint.

The brazing process is widely used because a great many metals can be effectively joined in that manner with a minimum of filler material and at relatively low temperatures compared with welding. Simple carbon steels as well as cast iron, copper, nickel, Monel, Inconel, brass, bronze and other metals are commonly brazed. Dissimilar metals, even with wide variations in melting points may be joined by brazing.

Brazing materials commonly used fall into two broad groups: silver base and copper base alloys. The relatively low melting points of the eutectics of the silver-copper and silver-copper-zinc alloys and their excellent flow characteristics allow their use for nearly all metals. The melting points of these alloys range from about 1150 to 1600 F. The copper base brazing compositions generally contain a considerable percentage of zinc and may also include nickel, tin and phosphorus. These alloys melt from about 1600 to 2100 F, and are generally available as wire, sheet, powder or lumps, to provide the form best suited for every application. Copper and copper alloys are commonly brazed with lower melting bronze filler metal. Nickel alloys are joined by using silver brazing alloys.

The surfaces to be joined must be free of oxide to obtain a good bond. It is therefore necessary either to protect the surfaces from the oxidation which may occur during heating, or to use a flux which will remove oxide by chemical means. The flux chosen should be highly fluid at the brazing temperature, be readily floated to the surface of the brazing metal, and of course, must react with the metal oxide.

Common fluxes are chlorides, fluorides and borates. They are available as pastes and as saturated solutions. Recently fluxes in stick form have been made available. Flux may be applied to the surfaces being joined before brazing or as a powder with the brazing metal. Since entrapped slag causes lowered bond strength and fluxes are usually corrosive to the joined metals in service, flux must not be entrapped in the joint.

Heating for brazing may be done by oxyacetylene torch, in a furnace, by dip technique or by electric means. The latter may be provided by the carbon arc, electric resistance, or induction methods.

Joint design and preparation are of prime importance. Surfaces to be

# Basic Power Plant FIGURING

## A Review for Old-Timers — A Must for Young-Timers

By **WILLIAM H. ENGELMAN**, Mechanical Engineer
Department of Water & Light, City of Cleveland, Ohio

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### Calculations for Bleeder Turbine Driving a 40 M.G.D. Pump

**A 40-mgd pump operating against a total head of 214 ft is driven by a steam turbine with a steam pressure of 465 psia and 750 F total steam temperature. The efficiency of the pump is 88.0 per cent. The turbine has a water rate of 7.2 lb per brake hphr. The exhaust pressure is 29 in. of vacuum referred to a 30-in. barometer. Steam for feedwater heating is bled at three points. The tabulation below gives the data from which other calculations were made.**

Table I. Data on steam turbine, from which calculations are made

| Points Taken | Pressure psia | Enthalpy Btu per lb | Steam Ratio |
|---|---|---|---|
| Exhaust | 29.0" Vac. | 1,004 | 0.000 |
| No. 1 | 6.75 | 1,112 | 0.285 |
| No. 2 | 28.00 | 1,197 | 0.505 |
| No. 3 | 88.00 | 1,275 | 0.710 |
| Throttle | 465.00 | 1,386.5 | 1.000 |

Table II. Data calculated on steam turbine from Table I

| | Steam at Throttle | Extraction Points | | | Exhaust at Condenser |
|---|---|---|---|---|---|
| | | 3 | 2 | 1 | |
| Pressure psia | 465 | 88.0 | 28.0 | 6.75 | 29.0" Vac. |
| Total Temp. | 750 | 489.4 | 314.7 | 175.2 | 79.03 |
| Sat. Steam F. | 459.6 | 318.7 | 246.4 | 175.2 | 79.03 |
| Superheat | 290.4 | 170.7 | 68.3 | 2.4% M | 8.7% Moist |
| Btu per lb. | 1386.5 | 1275 | 1197 | 1112 | 1004 |
| Entropy | 1.6440 | 1.7180 | 1.7511 | 1.7820 | 1.8680 |
| Steam Ratio | 1.00 | 0.710 | 0.505 | 0.285 | 0 |
| Btu Diff. | 382.5 | 271.0 | 193.0 | 108.0 | 0 |
| Btu. Drop | 0 | 111.5 | 78.0 | 85.0 | 108.0 |

The steam ratio is the ratio of the amount of steam extracted at a given point to the amount of steam that must be added to the throttle in order to maintain the same load. For example, if 1000 lb of steam per hr, is extracted from No. 1 extraction point, then 285 lb per hour must be added at the throttle in order to maintain the output. This method is a very close approximation and applies to the full load point only.

$$\text{Water hp} = \frac{40{,}000{,}000 \times 8.33 \times 214}{24 \times 1{,}980{,}000} = 1{,}500$$

Brake hp $= 1{,}500 \div 0.88 = 1{,}705$

$1{,}705 \times 7.2 = 12{,}276$ lb steam per hr, straight condensing, no extraction.

$1{,}386.5 - 79 + 32 = 1{,}339.5$ Btu per lb or heat chargeable

Total $= 1{,}339.5 \times 12{,}276 = 16{,}443{,}000$ Btu per hr in steam

$$\text{Duty} = \frac{2{,}971{,}033{,}000 \times 1{,}000{,}000}{16{,}443{,}000} = 180{,}680{,}000 \text{ ft lb per million Btu.}$$

Basing the calculations on 70 per cent efficiency of the adiabatic heat drop and allowing 2 per cent for losses external to the turbine casing,

Adiabatic heat drop $= 1386.5 - 883 = 503.5$ Btu.

and $503.5 \times .70 \times (1.0 - 0.02) = 345.5$ Btu available.

Work done $= 345.5 \times 778 = 268{,}800$ ft lb per lb steam

$$\frac{\text{Ft lb per hour}}{\text{Ft lb per lb steam}} = \frac{2{,}971{,}033{,}000}{268{,}800} = 11{,}050 \text{ lb steam per hr}$$

joined besides being free of oxide must be clean and free of oil or foreign matter. It is advisable to keep clearances within a few thousandths of an inch for maximum strength, the exact distance between surfaces to be joined depending to some extent on the heating means, the type of brazing alloy selected and the design of the part. Butt joints are undesirable because of low resultant strength; lap braze and scarfed joints should be used instead.

When metals are correctly brazed the joint will have ample strength and ductility for a great many applications. It is understandable, therefore, that brazed joints are finding increasing use for new applications, as for example, the use of gold brazing of corrosion resistant metals for corrosive conditions, and that brazing is now commonly used as a production method. It is a wise precaution, nevertheless, to test brazed joints under conditions representing severe service before going into production.—*Tempil Topics.*

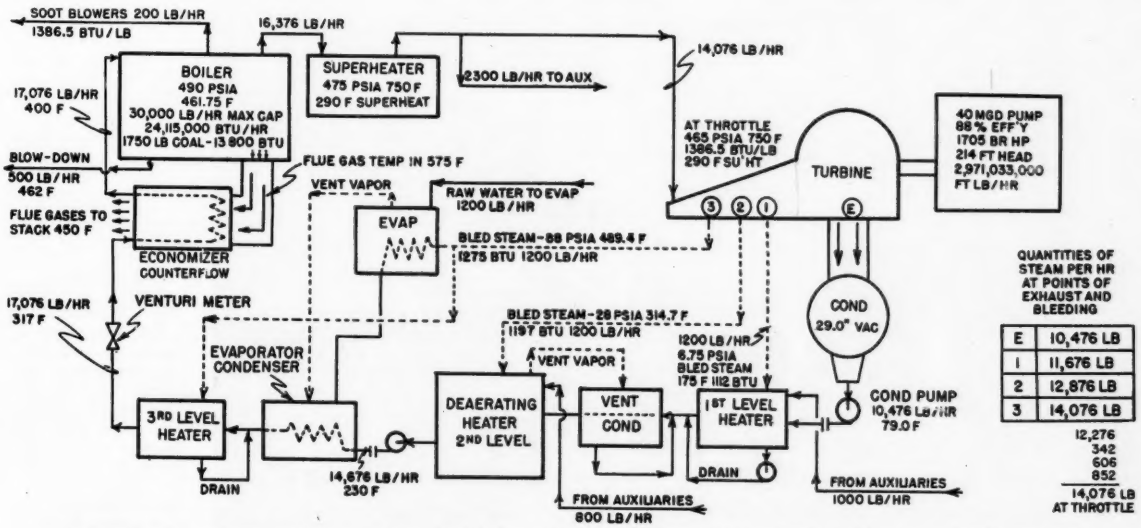
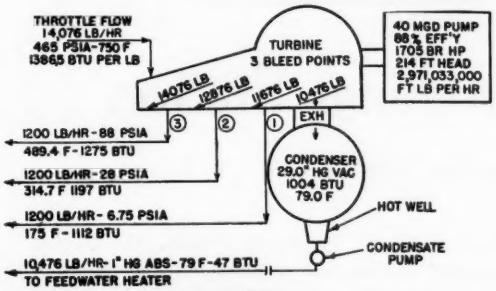



Fig. 1. Typical pumping station preliminary heat balance for a new boiler and 40-mgd turbine-driven centrifugal pump unit




| POINT NO. | LB STEAM EXTRACTED | STEAM RATIO | LB ADDED AT THROTTLE |
|---|---|---|---|
| 1 | 1200 | 0.285 | 342 |
| 2 | 1200 | 0.505 | 606 |
| 3 | 1200 | 0.710 | 852 |
| TOTAL | 3600 | ---- | 1800 |

| | |
|---|---|
| STRAIGHT CONDENSING | 12,276 LB/HR |
| ADDED AT THROTTLE | 1800 LB/HR |
| TOTAL FLOW | 14,076 LB/HR |
| STEAM EXTRACTED | 3600 LB/HR |
| FLOW TO CONDENSER | 10,476 LB/HR |

1800 LB OF STEAM MUST BE ADDED AT THE THROTTLE IN ORDER TO COMPENSATE FOR 3600 LB BLED AT THE THREE GIVEN POINTS

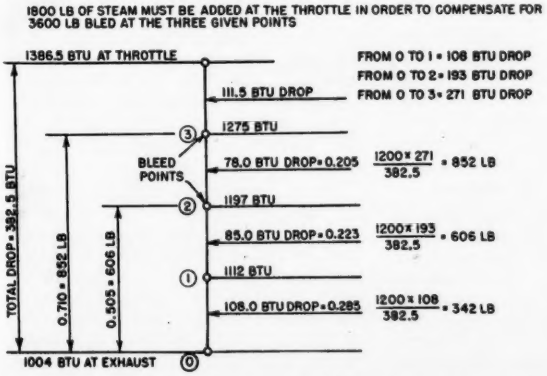

1386.5 BTU AT THROTTLE
FROM 0 TO 1 = 108 BTU DROP
FROM 0 TO 2 = 193 BTU DROP
FROM 0 TO 3 = 271 BTU DROP
111.5 BTU DROP
3
1275 BTU
BLEED
POINTS
78.0 BTU DROP = 0.205
1200 × 271 / 382.5 = 852 LB
2
1197 BTU
85.0 BTU DROP = 0.223
1200 × 193 / 382.5 = 606 LB
1
1112 BTU
108.0 BTU DROP = 0.285
1200 × 108 / 382.5 = 342 LB
TOTAL DROP = 382.5 BTU
0.710 = 852 LB
0.505 = 606 LB
1004 BTU AT EXHAUST
0

Fig. 2. Data sheet by William H. Engelman showing steam calculations for condensing extraction turbine driving 40-mgd pump

## Condenser Capacity and Cooling Water Requirements

$h_f$ in condensate 79.0 — 32 = 47.0 Btu per lb, (heat in liquid)
Steam entering condenser 1386.5 — (2545 ÷ 7.2) = 1,033 Btu.
Circulating water must absorb 1,033 — 47 = 986 Btu per lb.
Assuming a 12-deg cooling in the condenser,

$$\text{Lb circ. water per lb steam} = \frac{986}{79 - 67} = \frac{986}{12} = 82.2 \text{ lb water}$$

$$\text{Lb of water per min} = \frac{12{,}276 \times 82.2}{60} = 17{,}000 \text{ lb cooling water per min}$$

Gallons per minute = 17,000 ÷ 8.33 = 2,040 gpm

The amount of cooling water required by the condenser is dependent upon the temperature of the water due to seasonal changes. In the summer the temperature might reach 85 F, and in the winter it may drop to 33 F.

The duty of a pump is the useful work done in foot-pounds per 1,000 lb of dry steam or per 1,000,000 btu.

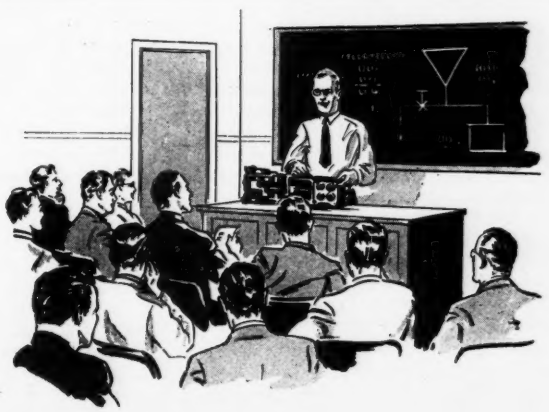


Fig. 1. View between condenser and condenser circulating pumps in O. H. Hutchings Station. This shows ribbons over wire mesh on head of one of the exhausts of forced air (upper center). Air is obtained from roof towers, filtered, and blown into basement area

# Ventilation at O. H. Hutchings Station

By **C. RUSSELL DOLE** Architectural Engineer, The Dayton Power and Light Company

**How ventilation system of O. H. Hutchings Station, The Dayton Power and Light Company, is designed, constructed and operated . . . Contributes greatly to efficiency of operation and provides pleasant working conditions . . . Station of semi-outdoor design, described in February 1949 issue . . . All ventilation air is filtered . . . Control rooms and office section have year-round air conditioning . . . Details of air supply, fans, ducts, cooling and heating**

THE NEW O. H. Hutchings Station of The Dayton Power and Light Company started operations on July 12, 1948. The station is a model of 'push button' operation; and contributing in no small measure to the efficiency of operation and the pleasantness of working conditons is the ventilating system of the station.

The Station is of the semi-outdoor type with about one-half of each of the boilers exposed on three sides. This type of station was decided upon for the reason that economies could be effected in original station construction and, further, the station could go on the line sooner, because lesser amounts of construction material, in critically short supply at the time the station was built following the close of World War II, would be needed in construction. A detailed description of the entire station was given in POWER GENERATION, February, 1949 issue.

The boilers are enclosed with insulating aluminum panels on the exposed sides at the burner and drum levels where access is required by operators at frequent intervals. With only about half the boilers enclosed, the ventilating system of the station is relieved of handling a large amount of heat radiated from the boilers.

### All Ventilation Air is Filtered

All the air used for ventilation is filtered. The air for the boiler room auxiliary bay and the turbine room areas is taken from a tower above the roof through Dollinger automatic, continuous curtain-type air filters. Air cleaned in this manner is forced through a direct system to the various parts of the building by two Buffalo Forge load-limit fans, having a combined capacity of 300,000 cfm. The present installation is sufficient for the two 60,000-kw units now in operation. Additional ventilating units are planned for each pair of generating units to be added to the station.

The duct system that carries this air has been carefully designed to permit discharge at various levels and locations. Particular attention has been paid to delivering air as close as possible to such places of possible discomfort as the regions of pulverizer mills, boiler walkways, heater bay and boiler feed pumps.

Air is exhausted from the boiler auxiliary and turbine areas by

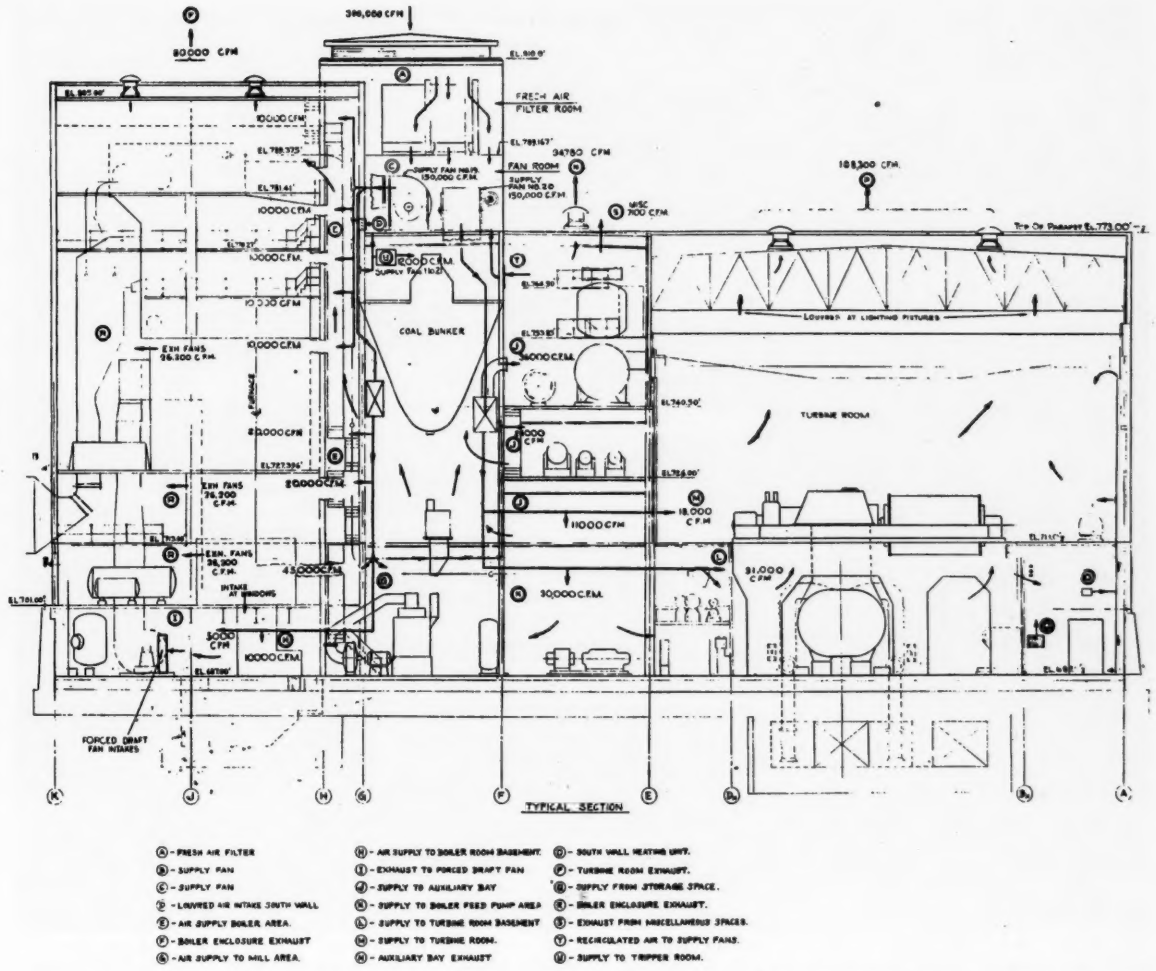

380,000 CFM
80000 CFM
FRESH AIR FILTER ROOM
94780 CFM
FAN ROOM
SUPPLY FAN NO.1 150,000 C.F.M.
SUPPLY FAN NO.2 150,000 C.F.M.
MISC 700 C.F.M.
188,300 CFM
COAL BUNKER
TURBINE ROOM
LOUVERS AT LIGHTING FIXTURES
EXH FANS 76,200 C.F.M.
EXH. FANS 38,100 C.F.M.
INTAKE AT WINDOWS
11000 C.F.M.
18,000 C.F.M.
91,000 C.F.M.
30,000 C.F.M.
5000 CFM
FORCED DRAFT FAN INTAKES
TYPICAL SECTION
Ⓐ - FRESH AIR FILTER
Ⓑ - SUPPLY FAN
Ⓒ - SUPPLY FAN
Ⓓ - LOUVRED AIR INTAKE SOUTH WALL
Ⓔ - AIR SUPPLY BOILER AREA.
Ⓕ - BOILER ENCLOSURE EXHAUST
Ⓖ - AIR SUPPLY TO MILL AREA.
Ⓗ - AIR SUPPLY TO BOILER ROOM BASEMENT.
Ⓘ - EXHAUST TO FORCED DRAFT FAN
Ⓙ - SUPPLY TO AUXILIARY BAY
Ⓚ - SUPPLY TO BOILER FEED PUMP AREA
Ⓛ - SUPPLY TO TURBINE ROOM BASEMENT
Ⓜ - SUPPLY TO TURBINE ROOM.
Ⓝ - AUXILIARY BAY EXHAUST
Ⓞ - SOUTH WALL HEATING UNIT.
Ⓟ - TURBINE ROOM EXHAUST.
Ⓠ - SUPPLY FROM STORAGE SPACE.
Ⓡ - BOILER ENCLOSURE EXHAUST.
Ⓢ - EXHAUST FROM MISCELLANEOUS SPACES.
Ⓣ - RECIRCULATED AIR TO SUPPLY FANS.
Ⓤ - SUPPLY TO TRIPPER ROOM.

Fig. 2. Flow diagram of the ventilation system, main plant section, O. H. Hutchings Station, The Dayton Power and Light Company

Fig. 3. View of ventilating system at turbine floor level in O. H. Hutchings Station. Streamers from ventilating louvers above doors show air entering turbine area from towers on station roof. Streamers point in direction of air current, which is downward and over turbine floor area

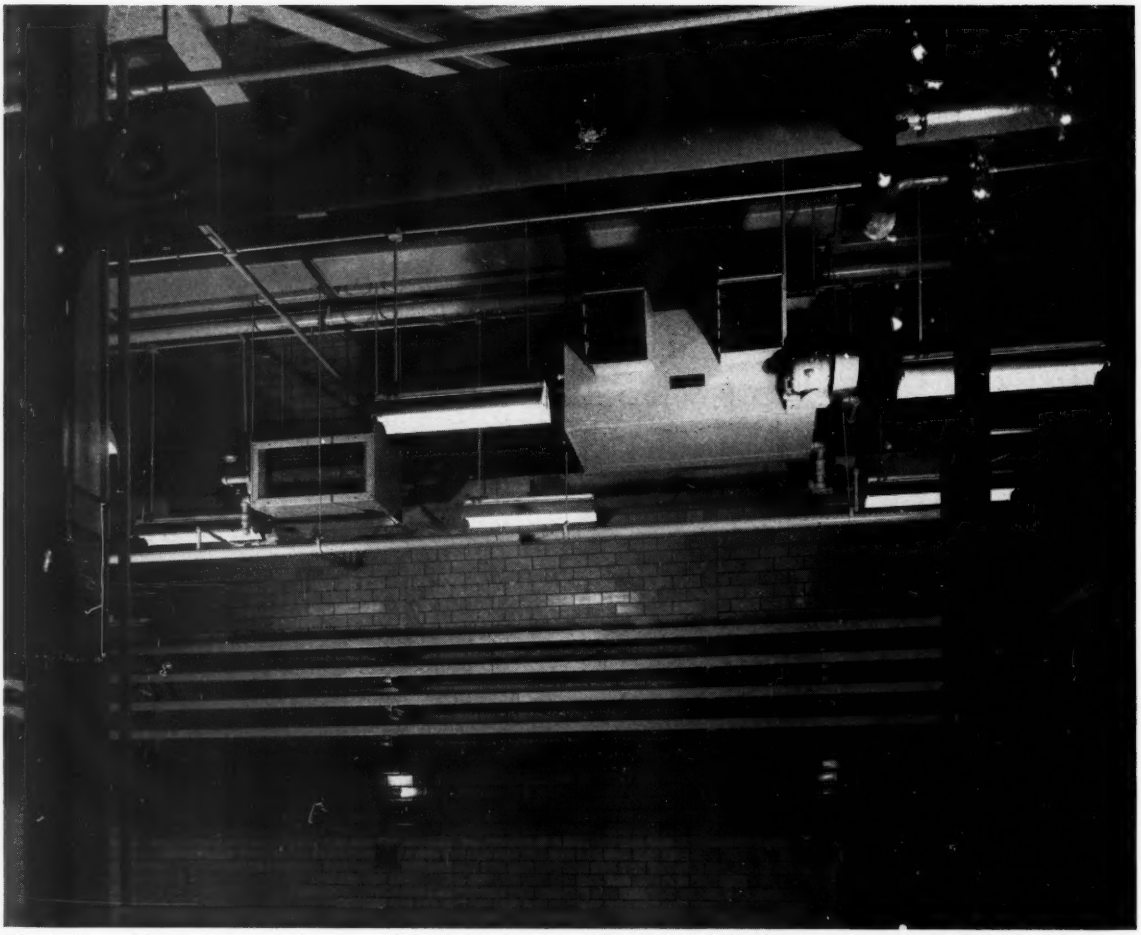


Fig. 4. View of heating system in basement of O. H. Hutchings Station. Upper right-hand:—Steam heating unit for heating Station in winter when station steam is available. To left is gas-fired, forced-air heating system for use if station steam is not available

means of propeller type fans in the walls of the boiler enclosures and DeBothezat fan-type roof ventilators. Fans and duct systems have been installed to remove air from all rooms ventilated but not air conditioned.

The forced-draft fans are arranged so that they can assist in the ventilation of the station by taking air from the station basement during hot weather when considerable air movement is desirable and from the outside in winter in order to conserve heat in the building.

Steam unit heaters have been installed in the auxiliary bay and turbine room to supply heat, if necessary, during periods of extreme cold if they should occur at the same time that a unit is out of service.

### Some Rooms Air Conditioned

The mechanical control room is air conditioned for both summer and winter operations. Mechanical refrigeration is used for cooling, employing freon and a Frigidaire compressor. The filtered fresh air is supplied by the ventilating towers. The return air is mixed with fresh air as required and passed through an American Air Filter Co. electrostatic air filter. The air is then heated or cooled as required and supplied to the room. The mixing chamber, fans and coils are in a room adjacent to the control room. The refrigeration compressor is located in the pump bay in the basement of the station so as to provide easy access for maintenance and inspection during operation.

The service building or office section of the station is year-round air conditioned except for the locker rooms, assembly room and kitchen. Steps are being taken now to air condition the assembly room, because it was found that the room is being used for holding a greater number of meetings during the summer than was originally anticipated. Air conditioning cooling is secured by using well water at about 54 F in fin-type coils. Dehumidification is accomplished by using lithium chloride, in a Surface Combustion Kathabar unit. Steam coils in the conditioning units supply heat when necessary.

The electrical control room is supplied with conditioned air from the service building air conditioning room on an isolated unit, which includes an electrostatic filter to filter all the air supplied to this room.

Throughout the station, temperature control is effected by means of a pneumatic temperature control system arranged for automatic control in summer or winter.

Outlying buildings such as the gate house, well houses, and operating space in the car dumper and crusher houses, all are heated with electric unit heaters. The oil storage house is provided with gas fired unit heaters.

The effectiveness of the ventilating system for different areas in the station is reflected in the following tabulation for a specific day (July 28, 1949).

| For July 28, 1949 | TEMPERATURE READING |
|---|---|
| Outside conditions in the shade | 93.5 F |
| Temperature in station manager's office | 81.2 F |
| Temperature in electric control room | 78.5 F |
| Temperature in mechanical control room | 79.9 F |
| Temperature in turbine area, floor level | 100.6 F |
| Temperature 5 feet from boiler at firing level | 105.2 F |

# New Versenate Test for Total Water Hardness Eliminates False End Points

By F. R. McCRUMB
W. A. Taylor & Company

FOR MANY YEARS, the total hardness of water has been determined by the soap test. The calcium and magnesium salts, which constitute hardness, are precipitated by soap and no lather can be produced until a slight excess of soap is present. In the soap test, standard soap solution is added to a measured sample of water. The soap solution is added in small quantities from a burette and the sample vigorously shaken until a lather is formed which will stand up for five minutes. The quantity of soap solution required is a measure of the total hardness.

### False End Points With Soap Test

Such a procedure is slow and tedious since the sample may have to be shaken a number of times before the end point is reached. In addition, the accuracy of the method is influenced by the ratio of calcium and magnesium, the total concentration, the method of shaking, the operator's idea of a permanent lather and the stability of the standard soap solution. Several modifications of the soap test have been developed and in the hands of an experienced operator, fairly good results may be secured. However, for routine control in the hands of a busy operator, the test may frequently give misleading information.

Perhaps the most familiar test in boiler water practice is the determination of alkalinity in which a standard acid solution is added to a measured sample of water in the presence of an indicator dye until the dye just changes color.* It has long been realized that a hardness test which functioned similarly to the alkalinity test, would be more satisfactory than the soap test.

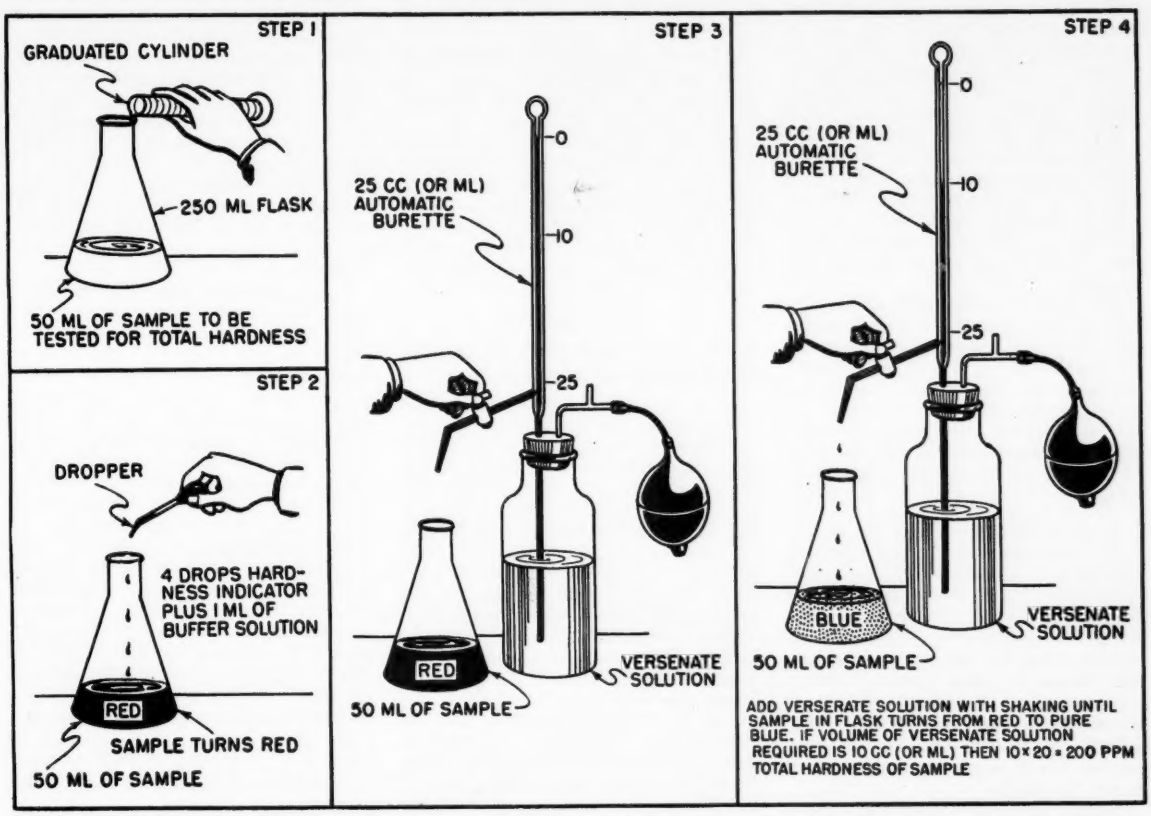
Such a test has recently been developed by Schwarzenbach and others at the University of Zurich, who found that certain organic acids form stable complex compounds with calcium and magnesium, and that these reactions can be employed for the determination of hardness. The method has been investigated further by Diehl and Hach at Iowa State College.

*See: How to Test Water in the Boiler Room, by E. O. Davis, *Power Plant Engineering*, October 1945.

### New Sodium Versenate Has Definite Color End Point

The titrating agent in the new method is a standardized solution of sodium versenate. This reagent reacts with calcium and magnesium to form complex ions rendering the calcium and magnesium inactive, yet

*(Continued on page 102)*


STEP 1
GRADUATED CYLINDER
250 ML FLASK
50 ML OF SAMPLE TO BE TESTED FOR TOTAL HARDNESS
STEP 2
DROPPER
4 DROPS HARDNESS INDICATOR PLUS 1 ML OF BUFFER SOLUTION
RED
SAMPLE TURNS RED
50 ML OF SAMPLE
STEP 3
25 CC (OR ML) AUTOMATIC BURETTE
0
10
25
RED
VERSENATE SOLUTION
50 ML OF SAMPLE
STEP 4
25 CC (OR ML) AUTOMATIC BURETTE
0
10
25
BLUE
VERSENATE SOLUTION
50 ML OF SAMPLE
ADD VERSERATE SOLUTION WITH SHAKING UNTIL SAMPLE IN FLASK TURNS FROM RED TO PURE BLUE. IF VOLUME OF VERSENATE SOLUTION REQUIRED IS 10 CC (OR ML) THEN 10 × 20 = 200 PPM TOTAL HARDNESS OF SAMPLE

**Figs. 1-4. Step-by-step instructions for making the new total hardness test with versenate solution. No special equipment is required, merely the new chemical solutions plus the standard flask, burette (standard or automatic type), dropper, sample container used in any standard water testing kit**

**STEP 1—Into a 250-ml flask, pour 50 ml of the water to be tested for total hardness**

**STEP 2—With dropper, add 4 drops of hardness indicator and 1 ml of buffer solution. Mixture in flask will now be RED**

**STEP 3—Fill a standard or automatic burette with the versenate solution**

**STEP 4—Run versenate solution from burette into sample in flask, shaking flask vigorously from time to time, until sample turns BLUE. This is the end point. Read number of ml or cc drawn from burette, multiply by 20 to obtain total hardness in ppm (parts per millions)**

# Questions and Answers

**Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS**

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity.

Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, cooperate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

**Engineers who take the trouble to answer your question would appreciate some information from you, transmitted through the Q & A editor, on how their answers helped solve your problem. In doing this, indicate whether or not your comments could be published for the benefit of all readers.**

**Question No. 451**

## SHOULD HE USE ACCUMULATOR ON LINES TO STEAM PRESSES?

WE OPERATE two steam presses whose combined steam load varies from 2000 to 16,000 lb of steam over a 5-min. period. We also have a Corliss steam engine that requires from 7000 to 11,000 lb of steam per hour.

Operation of these presses causes considerable fluctuation in the water levels in our water-tube boilers and also in the steam pressure. This, of course, prevents best boiler operation and naturally the steam pressure fluctuations affect the engine operation.

We have been thinking of installing an accumulator on the steam line to these presses but have not been able to find much information on the construction and operation of an accumulator for such service.

Finally, is an accumulator the best thing, or can anything else be done to smooth out the boiler operation?

Ohio W. R. R.

*Editor's Note:— There is a detailed discussion of the construction, operation and control of the steam accumulator for such applications in a paper The Ruths Accumulator, by R. A. Langworthy,* Transactions ASME, *1928 Vol. 50 No. 15 FSP-50-33. Based on this paper, further treatment of the accumulator is given in the textbook Steam Power Plant Engineering, by Harding (John Wiley & Sons, Inc.) and in other textbooks.*

*Details of construction and operation of steam accumulators are given in the literature of manufacturers; a list of them has been sent to W.R.R.*

*Finally, note that he asks for suggestions on any other procedures that might smooth out his water level and pressure fluctuations.*

**Question No. 452**

## HOW DO YOU TEST A LADDER?

PLEASE advise as to the best method of testing a wooden ladder.

Wyoming E. H. H.

*Editor's Note:—Don't "jump to convulsions" about this one. It's a genuine question from the engineer of a utility power plant.*

*Just stop and think of the complications involving lawsuits and State workmen's compensation laws that could arise—and have arisen—from an accident caused by a ladder breaking under a workman. What tests will prove a wooden ladder is safe to climb before you climb it?*

**Answer No. 441**

## WHO CAN HELP THIS ENGINEER PUMP COLD MOLASSES?

HOW HIGH can a good reciprocating steam pump lift molasses at a temperature of 40 F? asked V. L. G. He said this molasses weighs 12 lb per gal, 45 deg Baumé, 86 deg Brix. He also wanted to know the method of figuring possible lift of molasses at various temperatures, also discharge pressure to deliver 400 gpm of molasses through a 10-in pipe 200 ft long at different temperatures.

Dan Gutleben, who has pumped millions of gallons of molasses, said (August issue) that V. L. G's. molasses can't be made to flow to the pump from an overhead tank.

Both Mr. Gutleben and B. D. Titus referred us to William E. Worcester, vice president of Kinney Mfg. Co. for the best data on the subject. Mr. Worcester was out of the country at the time and after his return was ill, so he has only recently been able to write to us. Here is his letter.

**It Cannot Be Done**

For a concise, practical reply our mutual friend, Dan Gutleben, gave the answer—"It cannot be done."

Actually, black strap molasses is so variable in its viscosity that just how impossible it is could only be told after viscosity tests are made on the particular molasses in question. It is rudimentary that all any pump can do is to remove all the air from the suction pipe, and that the height that any liquid will then rise in the suction pipe depends on the weight of the atmosphere at the particular location.

At sea level, with atmosphere weight of 14.7 lb psi, and a perfect pump which would remove all the air from the suction line, theoretically a molasses weighing 12 lb to the gallon would rise 23.3 ft in a suction line.

Actually there is no such steam pump. Then, too, molasses is viscous and a large part of the work to force the molasses through a pipe line is due to friction loss, so little pressure remains available for vertical lift.

Black strap molasses is not a uniform product and its viscosity varies by several hundred per cent. It is almost impossible to get accurate tests at 40 F with any ordinary viscosity measuring devices, but at higher temperatures some comparative viscosities may be of interest, as in the table.

When the tabulated viscosities are plotted on log-log paper almost all of them would indicate the molasses was semi-plastic at 40 F. You could probably walk on Sample No. 7.

To go into the pipe friction formula for viscous materials and the effect of entrained and dissolved gases is far beyond the space requirements of this column.

I prepared a paper entitled "Pumping Viscous Materials" for the First Pan American Engineering Congress held in Rio de Janeiro and Petropolis in July of this year. This covers the whole subject in considerable detail. The pipe friction formula on page 3 will supply V. L. G. with the mathematics. Tests on his particular grade of molasses will supply the absolute viscosity at various temperatures, and the consequent discharge pressure required for 400 gpm and 200 ft of 10-in. pipe can be determined.

However, unless he has some unusually low viscosity, Dan Gutleben's answer on pumping at 40 F is correct; namely, it is an impossible condition.

Boston, Mass. William E. Worcester

| | Sample No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 |
|---|---|---|---|---|---|---|---|
| Temp. F | 70 | 70 | 70 | 70 | 70 | 74 | 75 |
| Vis. SSU | 21500 | 3000 | 7518 | | 3475 | 11200 | 950000 |
| Vis. abs poises | 667 | 90.1 | 234 | 420 | 109 | 340 | 3000 |

*Editor's Note:- For copies of Mr. Worcester's paper, write the Q & A editor. Besides giving very practical data and curves on the characteristics of molasses and the pumping thereof—but not at 40 F—the paper contains valuable data on pumping such things as asphalt, wood resin, plastics, white lead and others, using rotary pumps.*

*And now, as a result of all the discussion of pumping molasses, comes this:*

**Question No. 453**

## CAN THEY USE MOLASSES AS A FUEL?

WE NOTICED the comments on Question No. 441 in the August issue, concerning technical data on molasses. We are interested in locating a source of data on the use of molasses as a fuel.

Baltimore, Md. P. F. S.

**Answer No. 446**

## WHY IS THIS CIRCUIT GROUNDED THROUGH A FUSE?

WHY COULDN'T we keep our big mouth shut? Why didn't we look before we leaped? Why didn't we—Oh, shucks!

We said, in the October issue, that the consensus of replies to this question was that a solid ground without a fuse was the proper thing. Well, we were wrong. The concensus was not in regard to the ground but in regard to the fuse.

What we should have said was that "there seems to be general agreement among the answers" that the FUSE shouldn't be used. Whether the circuit should be grounded or not—and how—is another question entirely.

For producing this confusion, we were very properly jacked up by B. G. Forbes. And it is especially maddening for an editor to make such a dumb mistake if it is going to cause confusion among Mr. Forbe's power plant and electrical staff who think so highly of POWER GENERATION and the Q & A Section—or any other readers who feel the same way. Just what happened, or why we made that mistake, we can't explain. Our apologies to every reader. Anyway, Mr. Forbes's letter about it brings out some more important points. Hear him.

### Further Comments from Forbes

With reference to Question No. 446 in the October issue, I note your statement that there seemed to be general agreement among the answers received that a solid ground with ground lamps is the correct procedure for the subject 220-v-system. Following this, you print letters from three contributors that are hardly compatible with your conclusions.

Mr. Hope describes the 3-phase ground detector and how to use it. No explanation is given, however, as to what advantage such a detector would be on a grounded delta system. He adds that he never saw a 220-v delta system grounded.

Mr. Chace states that it is not good practice to ground one leg of 3-phase delta or open delta systems.

Mr. Cooper cites the Code where in one brief paragraph the stipulations vary with voltage from "shall be" (150-v to ground) to "is recommended" (300-v to ground) to "may be" (higher voltages). Such a rule, in my opinion, indicates uncertainty on the part of its authors.

I am wondering if you or any of your readers ever asked for and received a satisfactory explanation of this rule from an enforcement authority. How can one solidly ground one leg of a 220-v delta system without exceeding the 150 v to ground stipulation of the Code? Doesn't that automatically rule out the compulsory grounding of 220-v systems?

A thorough understanding of the basic purposes of grounding would in itself dictate the methods to be followed. The present and almost universal practice of operating delta systems ungrounded is not old. Our own case as mentioned in my letter to you of September 1st on this subject is typical.

When a ground occurs on a modern ungrounded system why do the maintenance electricians stay everlastingly on the job until the ground is cleared? The answer is that they know only too well what would happen if a simultaneous ground should occur on another phase. They do not want to have an accidental ground develop into a short circuit. Grounding one phase invites the very trouble that so many mill electricians are constantly striving to avoid. One more question: Have any of your readers ever seen a Utility delta secondary installed within the past ten years that was grounded?

I am writing not to be controversial but rather with the object of directing your attention to the discrepancy between your conclusions and the printed answers, and thus avoid the misunderstanding and confusion which is bound to result in the minds of some of your readers.

I might add that POWER GENERATION is preferred to two other similar magazines by my power plant and electrical men and that the Q & A Department provides popular topics for lunch hour discussions. I am sure that there are going to be some repercussions from them on the subject of grounding as soon as the October issue starts to circulate.

Bridgeport, Conn. B. G. FORBES

### Line Should Have Solid Ground, No Fuse, says Butcher

IN THREE-WIRE A-C circuits, one phase is frequently grounded. It appears to me that someone made a mistake when a fuse was installed in the grounded line. Worse things than this have been done through error.

The fuse should be removed and the line grounded solid, unless there is something that has not been mentioned in the question.

I suggest that W. T. C. check with the power company.

Piney River, Va. IRA A. BUTCHER

**Answer No. 447**

## WHY DID MOTOR ROTOR OPERATE OFF CENTER?

WHEN CONNECTING up a new 300-hp, 2700-v, 60-amp, 3550-rpm motor to drive a boiler feed pump, said P. M. in the August issue, it was observed that the rotor had a "float" of 3/8 in. Before the coupling was made up, when the power was turned on to check rotation, the motor rotor swung over to the end away from the pump. After the coupling was made up, when the motor was started, its rotor swung the opposite way, up against the pump end bearing, which ran hot so the unit had to be shut down. Two other identical motors, installed at the same time on identical feed pumps, did not act in this way.

Now, P. M. wanted to know, where was the magnetic center of that first motor? Should the center be the same with load as without?

Suggestions as to the cause of the trouble were given by Messrs. Jones and Thomas in the October issue, with ideas for eliminating it. Here's more comment.

### Move Rotor or Field to Line up Centers

P. M.'s motor trouble is most apt to be that the vertical center line of the rotor does not line up with the center line of the magnetic field.

There is, however, the conflicting evidence that the rotor did kick over the other way when testing for rotation, without load, and this is puzzling.

I do not think, and have never heard or read, that the center of the magnetic field changes with the load, but it is reasonable to believe that the end-wise pull, due to any misalignment of the rotor with the center of the magnetic field, will vary with the load.

Since the motor will normally run loaded, and since the shoulder on the shaft did pull up hard against the bearing when loaded, we will have to disregard the behavior at no load, and seek our remedy to fit the loaded condition.

As the clearances in the pump are probably small, there are, no doubt, thrust bearings to limit float, (or prevent any float whatsoever), and there can be no suspicion that the pump was in any way to blame. I cannot think of anything else that would cause the behavior, except there might be a cooling or ventilating fan on the rotor shaft, but as the other motors ran OK, the fan idea may be ruled out.

Now for the remedy.

Either the rotor will have to be moved in relation to the magnetic field, or the magnetic field will have to be moved in relation to the rotor, depending on construction of the machine.

If the stator is bolted onto the base plate, independent of the bearings, the simplest way will be to move the stator *back* from the bearing that ran hot and not disturb anything else.

If the stator is integral with the frame, and the bearings in pedestals, bolted to the base, the bearings may be moved towards the pump enough to let the rotor find the center. But this will necessitate the moving of the coupling and possibly cutting off the end of the shaft, unless the whole motor may be moved back enough to clear the shaft, or the coupling is not flush with the end.

If neither of these things can be accomplished due to the construction, the rotor and shaft will have to be taken to a press and the rotor pressed on the shaft towards the bearing (the hot one).

Whichever is moved, the stator or the rotor, to bring about the new relation, will have to be moved at least one times the float and probably one and one-half times the float.

Not knowing the construction of the motor, it is hard to be definite. There also remains the possibility that the bearing shells can be moved endwise in the housings enough to make the new relation.

Seattle, Wash. P. A.

**Answer No. 448**

## WHAT MAKES TURBINE NO. 2 DROP LOAD AND LOSE VACUUM?

**How Q & A Readers Helped Find and Cure the Trouble**

HERE'S ANOTHER outstanding illustration of the way in which Q & A readers help each other out of a jam. We encounter many of them in talking with readers during plant calls, but not everybody has time or remembers to let us know when it happens.

Here, however, was a case of a turbine failing to carry load and losing vacuum at full load, said L. R. D. —and the power was needed to meet expected factory loads. Now L. R. D. has just written us that as a result of the answers to questions sent him and principally the comment of George G. Avant, October issue, the trouble has been found and the turbine now carries full load at 27½ in. vacuum. George, take a bow.

Ira A. Butcher in the same issue, mentioned the same point but did not emphasize it as Avant did. Also, in a letter received recently and not published, Marvin Persinger, referred to the same cause of the point. Other readers also included it with items to be investigated. But George was the first to point squarely at it.

For those who tuned in late, here are the details. Their No. 1 750-kw turbine generator, said L. R. D. August issue, is connected to a 2400-sq ft surface condenser and carries rated load with 165-psi inlet steam pressure and 27-in vacuum, with condensing water at 85 F.

Now No. 2 turbine, also of 750-kw capacity, is connected through a Y to two surface condensers of 1700 sq ft each—total 3400 sq ft.

The two condensers of No. 2 unit have ample circulating water at 85 F, separate discharge pipes and are connected to the same 2-stage steam jet air ejector and condensate pump.

This No. 2 turbine would carry up to 500 kw load with 145-psi inlet steam pressure and maintain 27 in. vacuum. But, if an attempt was made to increase load and steam pressure beyond these values, the vacuum gradually dropped and finally, with 23 in. of vacuum and 165 psi inlet steam pressure, the turbine was carrying only 400 kw.

How come and what to do? The extra power would be needed soon. Well, let L. R. D. tell what happened. Why the Condensate Pump Suction Caused All the Trouble.

The answer given by George G. Avant of Wilmington N. C. gave me the clue to the solution of the problem presented in my Question No. 448.

The situation was as follows: The other three condensers in the plant have their air ejection outlet connection on the side of the condenser; but the condenser of Turbine No. 2 which is connected to the lower part of the Y and gets all the water condensed in the last rows of blades and the gland leakage, which is condensate, has its outlet to air ejectors on the side of the hot well. That is to say, it is below the condenser; the other of the twin condensers of this unit gets only dry steam.

Another thing, we found that all the other condensers have the outlet for the pipe to the condensate pump the same size as the pump inlet, while this one had a smaller hole in the casting of the hot well than would correspond to the pipe size, thus throttling the pump suction.

This hole was reamed out and the trouble disappeared immediately. The turbine at once carried full load with full vacuum. The hot well has no gage glass, for if it had had one,

"He's from th' plant next door with th' new atomic reactor—says he's through fueling for th' day!!"

the trouble would have been apparent from the start.

Because we found the trouble, thanks to Mr. Avant's suggestion, it was not necessary to install one.

I appreciate very much the Q & A Engineer's Forum and consider it an excellent service of POWER GENERATION.

Ciudad Trujillo — L. R. D.
Republica Dominica

**Thanks for them kind words, L. R. D.**

Our thanks also to Marvin Persinger and George A. Aiken. Mr. Persinger, after a detailed analysis of the condenser performance, said the trouble might be due to the condenser fouling but added it could be caused by inability of the condensate pump to evacuate the condensate as load increases (as was the case). A hot well gage would show this; but without a gage glass, some other check was necessary.

George Aiken, after reading the October comments, wrote to offer his help to L. R. D. if the trouble had not been found—a typical offer we receive on many other questions.

H. R. Hohinelli wrote all the way from LaPlata in the Argentine, analyzing steam and water flows in the condenser and suggesting remedies.

These are typical of the interest shown. Once again heartiest thanks to everybody who co-operated.

**May Be Clogged Air Ejector Nozzle, says Miller**

IT IS POSSIBLE that L.R.D. may have air ejector trouble.

After having found his turbine blading clean and in a mechanically good condition and the vacuum system with no air leaks, it is quite possible that his trouble may lie in one of the steam jet air ejector nozzles. That is, the nozzle may be partially clogged.

The ejector suction vapor load with the 500-kw turbine load may not be too much for the clogged nozzle to handle without causing vacuum trouble, but when the turbine load is increased to 750 kw, the ejector's load of non-condensables is increased and may be more than the ejector can handle because of the clogged nozzle.

Partially clogged nozzles have the same effect on an ejector as reduced steam pressure. This causes an unstable condition and reduces the efficiency of the ejector.

Since he didn't mention anything about inspecting his air ejectors, L.R.D. should take a look at them, it may clear up his low vacuum problem.

Alton, Ill. — LOUIS B. MILLER

**Probable Causes May be in Condensate and Air Removal Equipment**

IT WAS NOT stated whether the trouble had developed after a period during which the machine had performed properly or had existed since the machine was first installed.

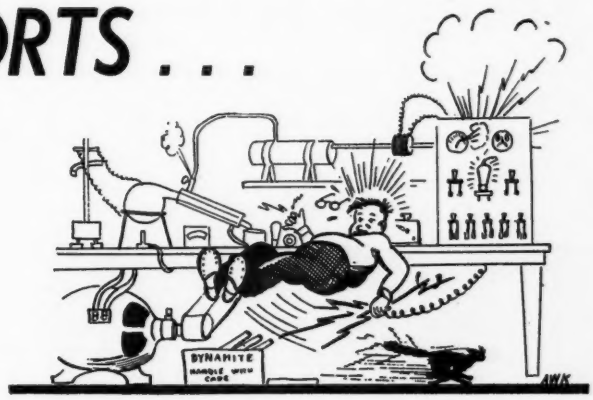
The two probable sources of trouble are the condensate removal and the air removal equipment, since it is apparent from the information given that the condenser surface and the cooling water supply are ample. A third possibility is that the condenser tubes are fouled, but this is so obvious that it is assumed this point has already been checked.

It would be well to check the rating of the condensate pump and all piping in the condensate system on *both* sides of the pump. If the rating is correct for the volume and head conditions, there is a strong possibility that there is some obstruction in the piping. A similar case is known where the trouble was a clogged nozzle in a feed water heater into which the condensate was discharged.

If the condensate system is found to be properly sized and in good condition, the air ejector should be checked for proper sizing. If the size is sufficient there remains only the possibility of an obstruction in the piping, ejector, or inter and after-condensers.

Iola, Kansas — EDGAR A. COOPER

# SHORTS . . .




YOU CAN probably think of several other more conventional uses for chipped ice than in the building industry. However, a clever way of making lightweight concrete blocks is by adding chipped ice to the mixture. When the ice melts, the resulting small holes contribute to reduced weight.

* * *

HAVE YOU ever wondered what attracts bees to flowers? It is not the smell of the flower or its nectar as is generally assumed. Rather, it is the movement of the petals. This can be easily proved by pulling the petals from a branch of apple flowers. When placed near bees, they will only hover over the flower and will not alight to collect the nectar.

* * *

THE THIRD 110,000 kilowatt generating unit at the new Sewaren Generating Station of Public Service Electric and Gas Co. has been placed in service. This brings the total electric generating capacity installed in Sewaren Generating Station to 330,000 kw and in the Public Service system to 1,515,300 kw.

The new turbine will operate with steam at 1050 F and 1,500 psi.

Power generated by the new unit will be sent out at 132,000 v for transmission to all parts of the Public Service system.

* * *

A RARE METAL, gallium, with some very unusual properties is now being produced in limited quantities. This metal is liquid above 86 F but will not boil until heated to approximately 3700 F. It has a density of 5.9, wets many surfaces such as glass and porcelain, and expands when solidified.

* * *

MAYBE THIS explains why Americans are sometimes down but never out—they bounce right back! Statistics show that the rubber consumption per capita in this country is 17 pounds per year. The balance of the world uses 0.9 pound per capita, while Canada, England and Russia use 11, 8, and 1½ pounds respectively.

* * *

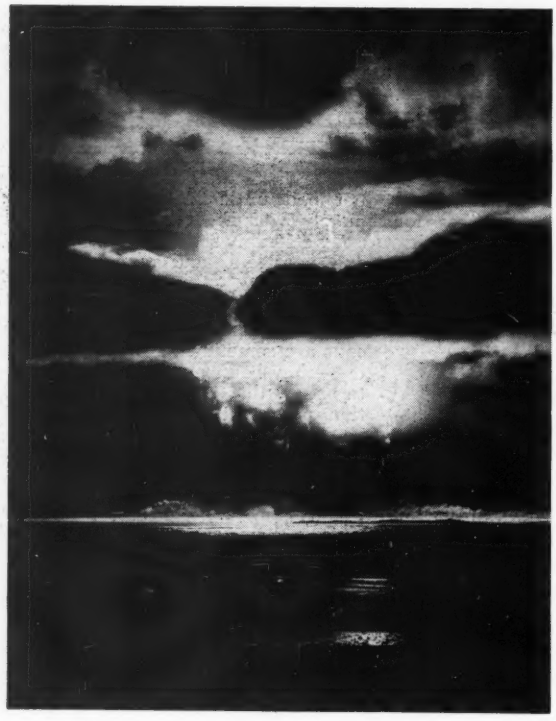
THE 166TH outdoor boiler unit designed and built by The Babcock & Wilcox Co., has gone into operation with the firing of the last of seven new Radiant type boilers installed at the Redondo Beach (Calif.) Steam Station of the Southern California Edison Company, Babcock & Wilcox officials said recently. This plant was described in detail in POWER GENERATION, July 1948 issue.

The seven boilers at the $38,000,000 plant will supply steam to four main steam turbine generators, each developing 66,000-kw and to two 6,000-kw auxiliary units. Electricity will be furnished for domestic, industrial and agricultural use, including power vital for irrigation in the southern and central counties of the state. The importance of a plentiful and dependable supply of electric energy was emphasized in California a year ago when a drouth caused a shortage of hydroelectric power.

# ATOMICS

# The Eniwetok Atomic Weapon Tests

THE Eniwetok atomic weapon tests held during the spring of 1948 have been shrouded in utmost secrecy, virtually nothing regarding the nature of these tests has ever been disclosed by the Atomic Energy Commission or by the Task Force which conducted these tests. About all that was released was the fact that "tests involving three atomic weapons, each of improved design, were successful in all respects and that the results indicated very substantial progress."



The fireball of an atomic bomb explosion emerges through the cloud formation forming the already familiar mushroom during the atomic weapons tests in the spring of 1948 at Eniwetok in the Pacific

Recently, however, in connection with the preparation of a Souvenir Booklet published by the Infantry Journal for personnel of Joint Task Force 7 who participated in the work relating to the tests, a series of photographs of the operation were released by the AEC and one of these photographs is shown here. These are official photographs taken by the Task Force photographic unit and cleared for public release by the U.S. Atomic Energy Commission.

The purpose of the Eniwetok tests was not to find the effects of atomic explosions on material and equipment as at Bikini. In general they were designed to fill in gaps in the knowledge gained at Bikini.

While no details of the tests have been disclosed it is very evident from the photographs that have now been released that the tests involved the explosion of atomic bombs of a type similar to those exploded at Alamagordo, Japan, and at the Bikini tests. The photographs show the same general type of fireball and mushroom smoke and cloud formation. One bomb, at least, was exploded from the top of a steel tower as at the first experimental test at Alamagordo. There seems to be one rather striking difference between the photographs of the Eniwetok tests and those taken at Bikini in that the fireball is more detached from the mushroom. Whether this is of any fundamental significance is a question which cannot be answered here. Whether the Eniwetok bombs were larger or more powerful than the Bikini bombs also is a question that cannot be answered—from the photographs, the explosions seem to be of about the same order of size but, of course, it is difficult to estimate the distance from which the photographs were taken. One thing is quite certain, however; the Eniwetok bombs were not duds. They were full size atomic explosions.

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**The above article is an abstract of an article in the November issue of ATOMICS Magazine.**

**The new ATOMICS represents a greatly expanded service to those who are interested in the theory and application of nuclear energy. It will keep readers abreast of what is happening in the field of atomic power development, in the industrial applications of radioactive isotopes, and in the use of nuclear energy in medicine, biology and agriculture. The November issue, in addition to the article abstracted on this page, contains other material of atomic interest including the sixth installment of the course in Nuclear Power Engineering which started in the June issue.**

**If you are interested in seeing this new magazine regularly, send in the attached coupon for a free copy. You will be under no obligation for this. ATOMICS will be published monthly, and as has been true of the articles which appeared in the ATOMICS section of Power Generation, the articles will be kept on a practical, understandable level.**


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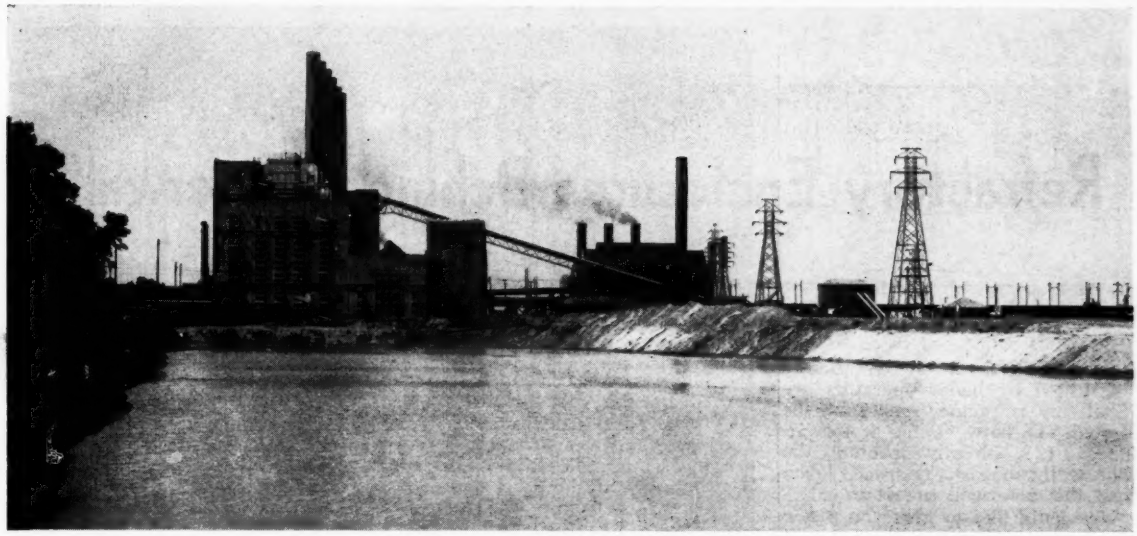


Fig. 1. Venice plant of Union Electric Co., St. Louis, Mo., with settling pool for fly ash in foreground

# Where Would You Put 300 Tons of Fly Ash Every Day?

**The Venice plant engineers of Union Electric Co. had to get rid of it somehow . . . Dusters weren't good enough . . . So they got the Army Engineers into the act . . . Together they worked out the scheme described here**

VENICE PLANT ENGINEERS face the prospect of disposing of 300 tons of fly ash a day! That's six carloads of fine powder ash that won't burn, won't grow anything, and can't be dumped into the river because it would soon become hazardous to navigation.

To solve the disposal problem, plant engineers set up a testing ground north of the plant. They discovered that when mixed with river water, the fly ash sets firm and makes excellent fill material. This also was found to be the cheapest means of disposal.

After a year of experiment it was decided, with the cooperation of the Army Engineers, to use the material to build a part at least of a new levee which was scheduled for construction to straighten out a pocket in the existing levee south of Venice Plant.

The first step, as described in *Union Electric Quarterly,* was to level and strip a thousand feet of sand and dig an inspection ditch to see that the river hadn't brought and buried any materials that would break the levee later. Two dikes were built up approximately 200 feet apart on either side of the level area. The area then was ready to receive fly ash.

The 300 tons of fly ash daily are collected by large electric precipitators, located alongside the plant's smokestacks. When the precipitators are cleaned, the fly ash falls into hoppers and is sent, under air pressure, to slurry tanks. Mixed with river water in the tanks, the fly ash is piped to the levee area to form a huge pool between the two dikes.

Peculiarly, when fly ash is added to muddy river water, it acts as a precipitant for all materials, causing them to settle quickly. So although the water enters the pool black and soupy-thick, at the opposite end, where it has cleared, it is clean and blue for draining back into the river.

Meanwhile, a firm levee is being built under the pool. In eight or nine months a one-thousand foot section will have been created . . . then, another set of toe-dikes will be erected for another pool, and another levee section.

Fig. 2. Fly ash water, as it enters the pool, is black and thick. Precipitation is rapid and islands are seen building up behind the pipe

# Refractory Enclosures Behind Waterwalls

By GEORGE P. REINTJES
President, George P. Reintjes Co.

QUESTIONS most frequently asked by boiler operators are "Shall my refractory enclosures be located (1) between the waterwall tubes; (2) directly behind the waterwall tubes or (3) spaced apart from the waterwall tubes?

We would like to give you a few of the pros and cons we have heard in this regard without delving into the reasons back of each individual theory:

1. The advantages claimed for spacing the refractories between the tubes are:

A. To permit a hotter furnace with less chance of the fires going out at low ratings. This is of importance when firing certain fuels in suspension.

B. To limit the amount of refractory surface subject to absorbing heat, which heat in turn may overheat the insulation.

C. To permit the refractories to release their heat by direct contact with the boiler tubes.

D. To permit the back side of the boiler tubes to remain cooler, thus creating a greater flow difference of the water within the boiler tubes, permitting the better scouring of the steam bubbles from the hot face of the tubes.

E. To better protect the tile anchoring studs from overheating and oxidizing.

F. Where fins are attached to the tubes, gases should not circulate behind the fins. Heating both sides of the fins at the same time will cause warpage of the fins because the additional heat cannot be absorbed by the tubes fast enough.

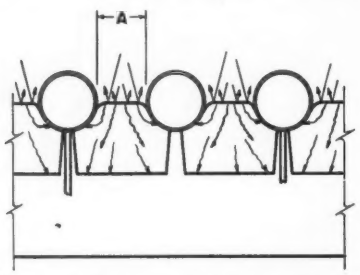



Fig. 1. "A" shows areas of refractories that may absorb heat. Refractories as shown may be 4½ in. thick but require no more eccentric loading than would a 2½ in. tile directly back of the tubes. Note the tapered tiles, preventing heat absorption by the anchoring stud bolts. The heat of the refractories is transferred to the boiler tube by convection

G. Where the tiles are attached to and placed between the tubes, the center of gravity of the refractory load is nearer to the tubes and consequently less strain on the supporting studs and the boiler tubes than where the weight of the refractories are eccentrically supported entirely behind the tubes.

2. The advantages claimed for placing the tiles directly behind the tube are:

A. The surface of the refractories which can absorb heat from the furnace is much greater than if the face of the refractories were limited to the space between the tubes, permitting greater refractory surface for reflecting heat toward the rear sides of the boiler tubes. This argument is limited by the spacing of the tubes; i.e. if tangential tube spacing is used, there can be no reflected heat.

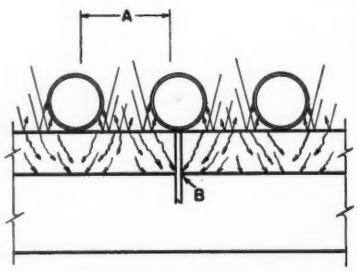



Fig. 2. Tiles placed directly back of the tubes. Note surface of boiler tube that can absorb radiant heat. "A" shows surface of walls that may absorb heat. "B" shows point at which stud bolts overheat and burn out. The thicker the refractory, the more this tendency. The thinner the refractories, the more readily will the stud bolt transfer its heat to the tubes. The thinner the refractories, the more the tendency to burn out the insulation

B. The initial cost of flat tiles placed behind of and held in alignment by the tubes is less in first cost, especially if standard fire brick shapes are used. This lower wall cost assists the boiler salesmen in lowering his boiler bid price.

C. The boiler tubes can be repaired or replaced without dismantling the refractory enclosure, but with difficulty.

D. If the furnace is too cool for the fuels burned, tiles can be inserted between the tubes and locked back of the tubes.

3. The advantages claimed for spacing the refractories apart from the waterwall tubes are:

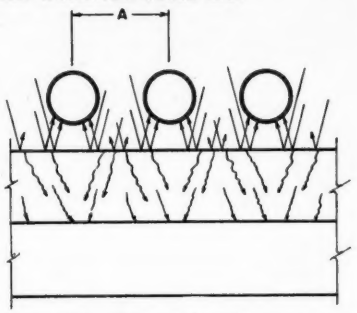



Fig. 3. All portions of the tube are exposed to reflected heat. Note space between tubes and refractories, permitting gases to travel around the tubes, heating the rear side of the tubes by convection

A. By locating the refractory enclosure entirely behind the waterwalls but spaced away from the tubes, the radiant heat is reflected to all sides of and also to the back of the tubes, the latter being impossible if the tiles were against the tubes.

B. When the refractories are spaced from the tubes, the furnace gases can circulate around the tubes, thus utilizing convection as well as radiant heat.

C. Where the refractories are spaced away from the tubes, the tubes can expand and contract independent of the expansion and contraction of the wall enclosure.

D. The boiler tubes can be repaired or replaced without dismantling the refractory enclosure.

E. If the furnace is too cool for the fuels burned, tiles can be inserted between the tubes and locked back of the tubes.

F. The vibrations and pulsations of the wall enclosure and the weight of the enclosure is not transferred to or sustained by the waterwalls.

G. If the refractories are spaced away from the tubes, even though the tubes are close spaced, a certain amount of gases will circulate behind the tubes and in front of the refractory enclosures, permitting additional heat absorption.

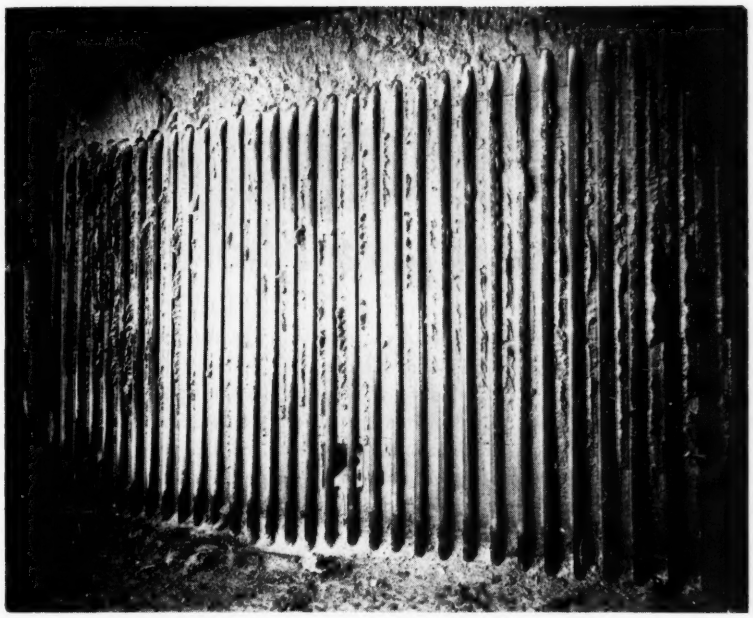


Fig. 4. Photograph showing dry, porous slag adhering to refractory wall back of waterwalls. Dry, porous slag does not reflect heat

All of the arguments for utilizing radiant heat from refractories back of boiler tubes of necessity are based upon the assumption that the refractories are not coated with slag, fly ash or any other materials that would stop the effective radiation of the heat.

All progressive suspended wall manufacturers can furnish refractory enclosure for waterwalls regardless of whether the boiler designer prefers the tiles placed between the tubes, directly back of the tubes or spaced away from the tubes. These wall companies can furnish the refractories in any thicknesses desired, the preferable refractory thickness being 3 and 4½ in.

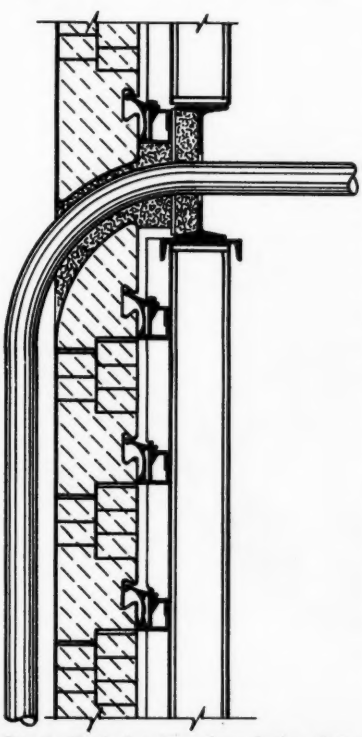


Fig. 5. Vertical section through the photograph shown in Fig. 4, at the point where the water tubes penetrate the walls

With a 3 in. thickness of refractory and where the tiles are located directly back of the waterwalls, there is less tendency to burn out the anchoring stud bolts than if the refractories were 4½ in. in thickness, the reason being that where the thinner refractory is used, the stud bolt absorbing the heat from the refractory can more readily dissipate this heat to the fluid medium within the boiler tube. On the other hand, where the thinner refractories are used, there is sometimes a temperature differential between the front and back of the refractories of less than 200 F.

To prevent the insulation from overheating and disintegrating, it is necessary to first apply to the back of the refractories super temperature plastic insulation consisting of diatomaceous earth or other insulation that will withstand more than 2,000 deg temperature. To overcome the lack of uniformity of the refractories and to avoid air space back of the refractories, it is advisable that this coating be of plastic material.

I do not presume to pass on the merits or demerits claimed by combustion and boiler engineers or by boiler salesmen, since there are many factors involved other than those stated herein. If, however, the boiler engineer claims that it is necessary to reflect heat to the rearward side of the boiler tubes, then we believe that it follows logically that the reflecting wall should be spaced sufficiently from the tubes to permit radiation to all portions of the rear of the tubes.

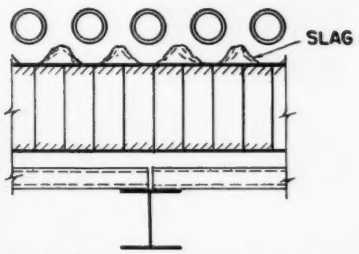



Fig. 6. Plan view through Fig. 4 showing areas of slag attached to the refractories

Certain combustion engineers in endeavoring to keep furnace temperatures down install not less than two rows of waterwall tubes in the center of the furnace. These tubes are located back to back so one row of tubes shields the other row of tubes, preventing the uniform heating of the tubes on all sides. They seldom approve of a single row of tubes at the center of the furnace *exposed on all sides to furnace heat radiation.* At the same time, they insist on heating the waterwall tubes on all sides, when the tubes are at the sides of the boiler.

## MICROWAVE RELAY CONTROL SYSTEM FOR SOUTHERN CALIFORNIA EDISON

A PUSH-BUTTON remote control system, in which radio and wire signals will operate eight electric power distribution stations covering a 450 mile area, is now being built in the General Electric Co. Switchgear Divisions. From one central point, the system will control initially 226 and ultimately 384 individual units of electric apparatus.

The supervisory control system will be installed in the Colton station of the Southern California Edison Co. From there a master control panel will switch on and off equipment in the outlying stations as needed by the power distribution network. In addition to controlling individual pieces of equipment, the supervisory control system will also report the readings on 28 instruments and 41 alarm indicators at the remote stations.

Two of the stations, in Redlands and Yucaipa, Calif., will be controlled by radio from the Colton station with equipment built by the G-E Electronics Department, Syracuse, N. Y. Using a microwave relay similar to the units which transmit television signals for network programs, coded impulses sent from Colton to the remote stations will activate control relays on the circuit breakers.

HEATING

# Central Heating Pays— Why Don't We Have More of It?

**Why do we permit a dozen tea-kettle chimneys in every block to pollute the sky and waste our heating money? asks the author . . . Put some numbers on the heating requirements of a typical business block and you'll wonder . . . Then oil up the lightning calculator and the author will figure how a central heating system would bring you a 25 per cent return on investment . . . Changing coal pile to a value for $25 per 1000 cu ft a good buy? . . . You've got to transport fuel anyway . . . Pipe lines and such may disturb shoulder chips, but proper planning could do the trick . . . How do the district heating systems stay in business if it doesn't pay? . . . Go then and do likewise, says the author, who does it for a group of big hospital buildings in Toronto . . . Many other people have done it; why not more of a good thing?**

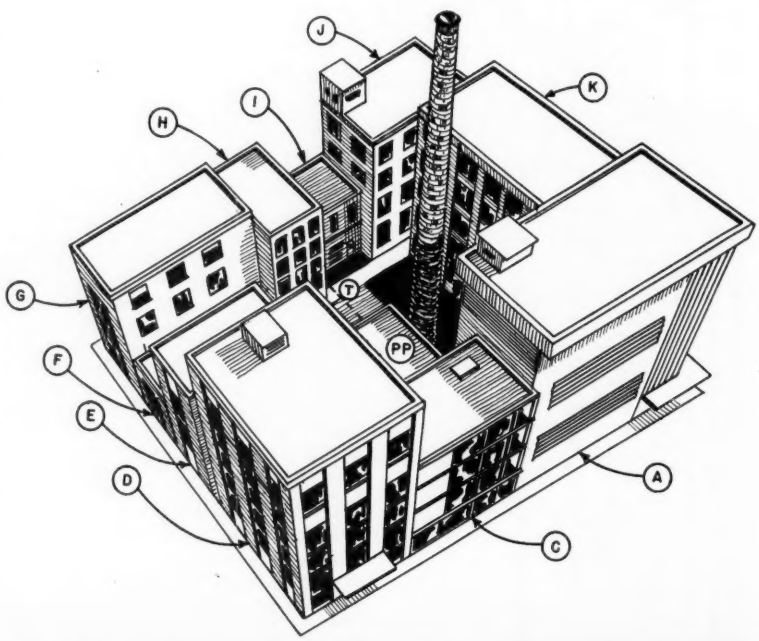
By **A. E. RICHARDS**
Christie St. Hospital, Toronto

LACK OF intelligent planning piles up a big account of excessive cost in heating the northern half of this continent. A one-eyed park bencher can see smoke from a dozen chimneys per block in any city or large town of these latitudes, each bearing witness that someone wants heat. And further, that one or more attendants maintain those fires, plus chute-bin, ashcans, shovels and so on. In some respects, oil units are not much better; they do obviate shovels and ashes and labor; but no one can deny a potential explosive hazard and the darned stuff finds its nefarious way onto everything in sight. There is not too much reliable evidence that oil will produce heat value dollar for dollar with bituminous coal. In many cases, we burn oil for different reasons.

Long time ago I handled a shift in a mediocre heating plant which paid its way handsomely, and reputedly has never yet failed to do just that. Steam, hot water and supervision of steam apparatus were supplied to about 4,800,000 cu ft of occupied buildings; a half million of this, as warehouse, required only half heat, so that the paying volume amounted to 4,500,000 cu ft.

Architectural heating practice specifies 1 EDR (equivalent direct radiation) per 55 cu ft occupied space, and 1 lb steam per hour per 4 EDR, or 1 lb steam per hour for each 220 cu ft. Heating is reckoned* in "degree days"; if outdoors is 0 F, indoor 70 F, every degree above zero outdoors reduces heat required by 1/70 theoretically; practically by about one per cent. Suppose outdoor temperature to average 20 F October-May inclusive, then 80 per cent theoretical load will be needed for the 243 days. If you like figures (besides the feminine gender) try the two methods for heating estimate, first as above, and alternately by using this arbitrary formula: 33 Btu per lb air per change (12.5 cu ft at 70 F). Tune in the lightning calculator and let's proceed.

Using the 220 cu ft-pound, for this 4,500,000 cu ft space a steam plant must furnish 20,455 lb steam per hr and would require close to 600 blr




**A typical business block, containing 5,785,500 cu ft of space with a central efficient steam heating plant instead of 10 small ones wasting coal. P.P. = Power Plant T.T. = Tunnels S = Number of stories**

*For any one day, when the mean temperature is less than 65 F, there exist as many degree-days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and 65 F.—*ASH & VE Guide*

# Troubled with water problems?

**SCALE**

**FOAMING**

**CORROSION**

**ALGAE**

**EMBRITTLEMENT**

**PRODUCT CONTAMINATION**

**STREAM POLLUTION**

As an engineer responsible for efficient plant operation, are you troubled by these industrial water problems? If so, the Betz Organization can be of assistance to you. Here, in one organization, you will find the facilities and services necessary for the efficient solution of all industrial water problems. Wherever your plant may be located, our nation-wide staff of engineers is ready to serve you. May we have a Betz engineer call to discuss your specific problems? There's no obligation, of course. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

# BETZ

**BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT**

hp (at 1 blr hp = 34.5 lb steam per hr at low pressure). With outdoor temperature averaging 20 F, as in preceding paragraph, you might think of deducting 20 per cent from horsepower requirements—but don't do it! It would be poor economy, leaving us with lowered stepins (or blue flannel dr-w-ers) during any below-zero weather encountered. Not uncommonly such protracted cold spells last for a week or more, and you may have contracted for a 70 F living-room rating.

Two 300-hp water-tube boilers should fill the bill. Water-tube units will produce more steam per square foot heating surface than other types, and are capable of 100 per cent overload for short periods; 50 per cent can be carried as a matter of course. It is obviously unwise to depend on one large unit for the whole plant; a break or shutdown for even a day would be more than embarrassing.

Our heat load so far shows 20,455 lb steam per hr less 20 per cent estimated o-d temperature allowance, or 16,370 lb per hr. Now, "you take the high road" and I'll take the same in guessing at serviced area population density (numbers, not mentality). One person per 2000 cu ft? That gives off 2200 persons.

Being neither Russ nor Kalmuk nor Eskimo, they wash and shower quite a bit. Hospitals reckon on 8 gal of hot water per person per day; we had better say 5 gal, 40 F to 160 F. Than 50 lb hot water at 120 Btu per lb is 6000 Btu per person for 365 days; boils down to about half a ton of coal daily.

**What Will Control Heating Plant Cost?**

If the adding machine is properly oiled, it now shows 16,370 × 24 × 243 lb (steam) and 1000 lb coal × 365 (hot water). First-class equipment, well-handled, will produce 10 lb steam per lb coal. So 95,469,840 lb steam, or 9,546,984 lb coal + 365,000 lb coal is approximately 5000 tons.

Plant cost, depreciation and such, might appear vague at first glance. I would hazard a guess at $200,000 and follow up with a 10 per cent allowance for interest and depreciation. Maintenance is often reckoned at 10 per cent of fuel cost in such layouts, and is not far wrong. Plants of this type have served their field efficiently for 25 years without major failure or replacement. Maintenance increases annually but is offset by leveling-off in depreciation write-offs. These figures are sufficiently liberal to allow for unforeseen items and for mediocre management.

Recap of Costs

| | |
|---|---|
| 5000 tons bituminous nut slack @ $9 | $45,000 |
| Maintenance, oil, minor repairs, 10% | 4,500 |
| Interest, depreciation | 20,000 |
| Wages, 7 men average $2,500 | 17,500 |
| Water, current, sundry | 1,000 |
| Total | $88,000 |

Now let's look at the rough sketch of a typical business block:—5,785,-000 cut ft.

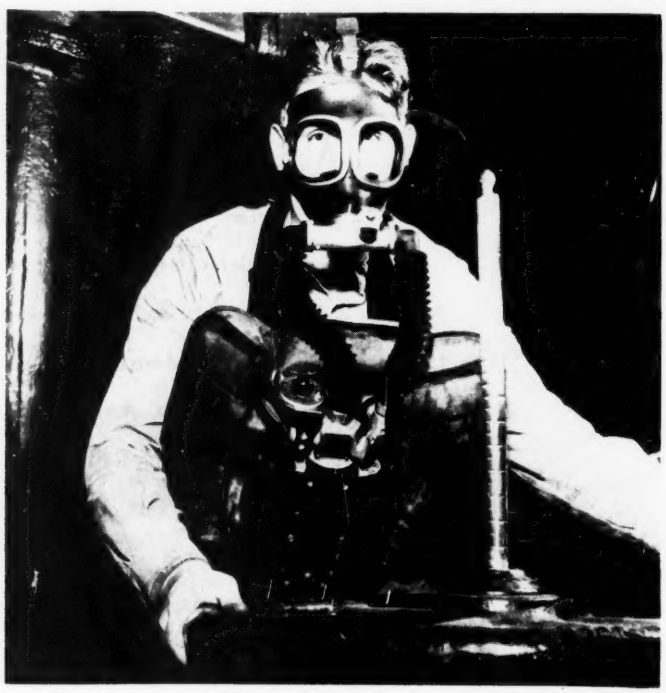
**How Much Will It Pay Off?**

From figures provided voluntarily by residence and office owners, I quote heating costs at $25 per 1000 cu ft yearly, without hired attendance or capital-cost depreciation; for instance, $400 yearly fuel-heat cost on a 16,000 cu ft residence or office suite. Services of fireman-janitor would more than quadruple that figure, and it can be used in these calculations as absolute minimum.

Our sketched block layout contains the equivalent of 361 units of 16,000 cu ft each. Gross annual income of the modest central plant like above would amount to $144,000, a nice, healthy margin of over 50,000 bucks. Any house, store, apartment-business owner or lessee who would maintain a heating plant and all its apurtenances, do or hire the work, rather than pay $25 per 1000 cu ft yearly, should take an elementary course in economics. He is more likely a sure fire prospect and shareholder, especially since it eliminates private installation and capital costs. Further there is pretty sure likelihood of handsome profit earned. The field is a veritable gold mine which has not been staked, nor even intelligently prospected.

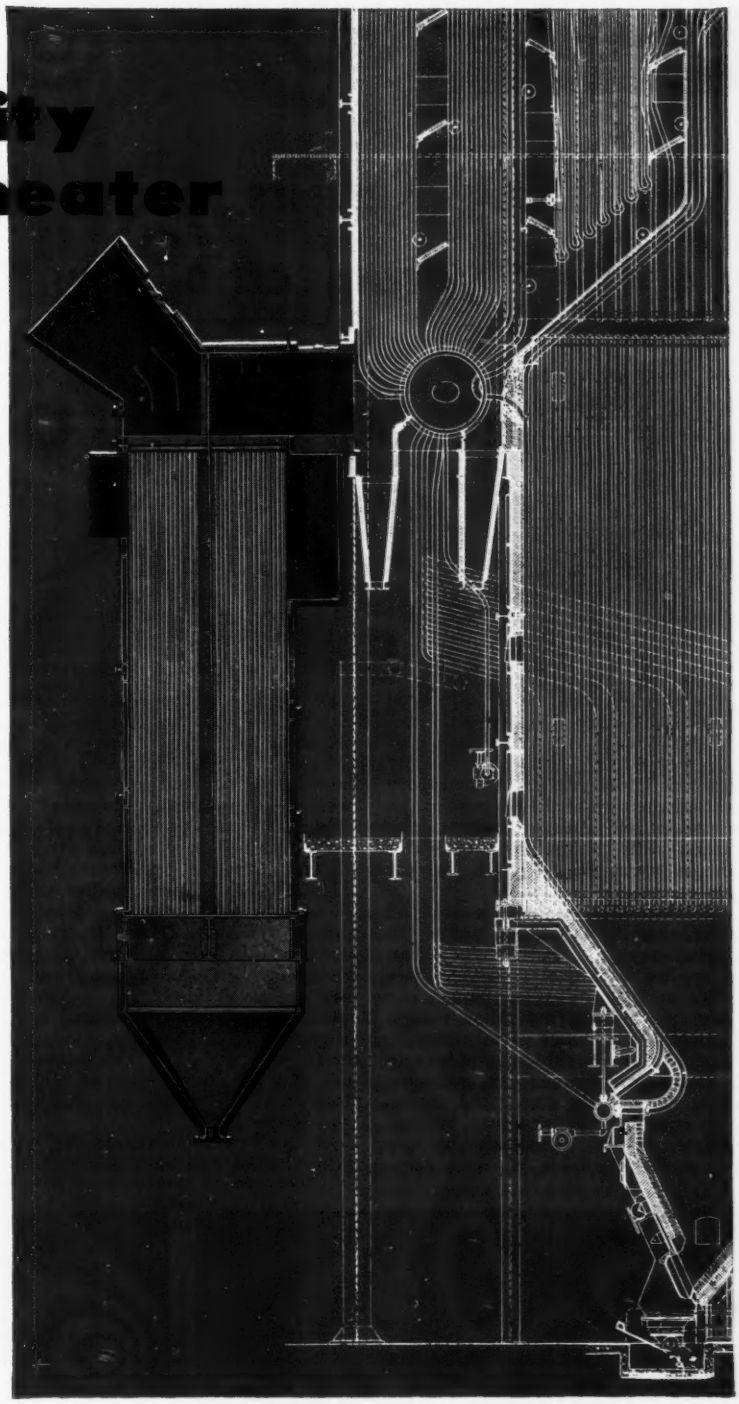
In less densely-occupied areas, or even as shown above, a larger plant will easily handle four blocks, with correspondingly increased gross and net income over that of the 6,000,-000 cu ft job illustrated. The one fair-sized insect in our ointment is underground service feeders and tunnels, particularly if serving more than one block. Sewers, telephone and power conduits, water mains, have touchy prior rights, carry chips on their epaulettes big as cordwood. Pre-construction planning would be the ideal answer, might even satisfy all concerned.

Bituminous fuel contains more heat units, ton for ton, than anthracite often used by householders, at little more than half the cost; comparative dollar efficiency is in ratio of about 9 to 5. Modern combustion equipment can be designed to burn soft coals practically without smoke and soot, both of which are wasted, unburned fuels. Chimney heat loss and exhaust from any oiled, steam-driven equipment, plus negligible leakage from valve stems, packing glands and such, are about the only losses from the system. Returns at vacuum by rotary pumps, fed to boilers and recirculated as steam. should show more Btu working than any other set-up I know of. It nearly approaches the ideal heat cycle.



Consolidated Edison Co. employee demonstrates freedom of movement given wearers of a new type oxygen mask that the company's emergency men and gas and electric production station personnel now have available for use in oxygen-deficient atmospheres. More than 1200 of the company's personnel have been trained in the use of the mask, known as Chemox, which was developed during the war for U. S. Navy fire-fighting teams and generates its own oxygen without any outside connections

# The Erie City Air Preheater



Heat Reclaiming is essential to economical performance of the modern steam generator. Erie City offers effective and economical heat reclaiming in its tubular air heater in single or double pass sections with parallel, counter or cross flow of air. The Erie City unit at the right is completely described in our new 40 page catalog. It is of the 2-pass design. *Flue Gas* enters at the top right and passes down thru the right bank of tubes—reverses travel and passes up thru the left tube bank.

*Air* enters at top left, passes downward around tubes in left bank and turns upward around the tubes in the right bank and enters a system of ducts leading to the fuel burning apparatus.

The resulting rise in temperature aids combustion, increases efficiency and can be accurately calculated to meet the requirements of any proposed installation.

For a complete description of this and all other units of an Erie City Steam Generator request Bulletin SB-30.

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MAINTENANCE

# Metallizing Repairs on Hydroelectric Equipment

**A brief but detailed description of the use of metallizing in the repair of worn and damaged hydraulic turbines and headgates. This cold process sets up no stresses and is conveniently applied. It is useful in the repair of runners, shafts, wicket-gate stems, etc.**

By JOHN E. WAKEFIELD

OFTEN FACED with an all-too-short time for repairs, the hydroelectric operation has even more to gain from metallizing than the steam plant. Modern metallizing units like the one shown in Fig. 1, for example, spray over 20 lb of stainless or carbon steels an hour. And they do it without building up dangerous heat in the part being sprayed. Those are the most important advantages of the process to the engineers and superintendents concerned with maintenance of water wheels, water wheel shafts, wicket gate stems and the like.

Metallizing is versatile too. About 40 different metals can be sprayed in present day guns. Any of them can be applied to almost any base, metallic or non-metallic. Thus, the same metallizing gun that resurfaces cavitated water wheel runners, using stainless steel, can apply zinc to dam gates or penstocks, and carbon steel to valve stems and shafts. It is equally easy to spray bronze, babbitt, copper, aluminum; in fact any metal available in wire form and of the proper diameter. Gun in Fig. 1 can be adapted to handle wires from $\frac{3}{16}$ in. dia down to 20 B & S gage.

### Metallizing is a Cold Process

Perhaps even more emphasis should be given to the fact that metallizing is essentially a cold process. That's important in hydroelectric equipment. Welding has been pretty generally discarded for mechanical repairs because of the heat. Welding sets up bad stresses and very often distorts parts badly.

Metallizing is quite another story. Metal comes out of the gun in the form of molten globules. Ninety-five per cent of them are still molten when they reach the work. Because they are so small, .001 to .010 in. in diameter, and are surrounded by a large volume of cool air, they cool the instant they land. The temperature of a part being sprayed seldom rises above 250 F, and can easily be kept below 150 F.

At such low temperatures, it's quite obvious that there is very little fusion between the sprayed particles and the base. That's why preparation of surfaces for metallizing is so important. Surfaces must be clean, free from rust, oxides, oil, grease or other surface contamination. They must be properly roughened to provide mechanical anchorage for the particles to key into when they land.

There are a number of different methods of preparation used today, all of which are quite satisfactory where properly used. The choice depends on the job to be done, type of metal to be sprayed, thickness required and so on. The importance of proper preparation cannot be stressed too much. In fact, almost without exception, the failures of metallized coatings which have occurred go back to improper preparation. Fortunately, the importance of preparation is now generally recognized. Excellent handbooks are available from manufacturers of metallizing equipment, describing the various methods in great detail. They should be referred to carefully and often.

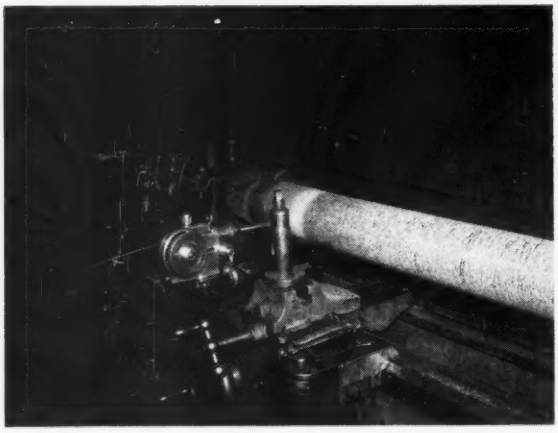

Fig. 1. This gun can be adapted to handle wires from $\frac{3}{16}$ in. dia down to 20 B & S gage.

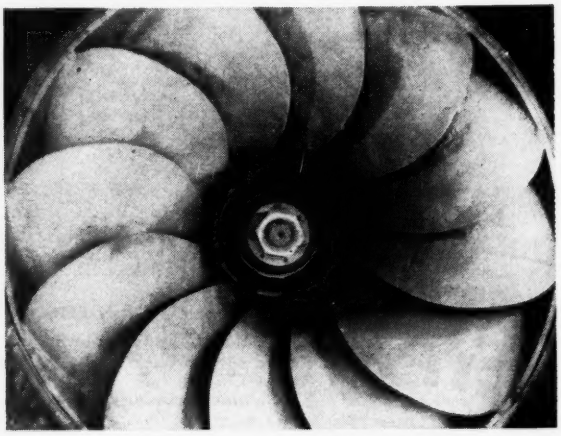

Fig. 2. A 1350-hp reaction type cavitated runner repaired by metallizing

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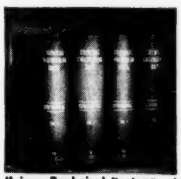

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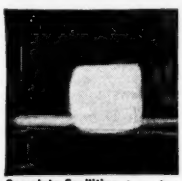

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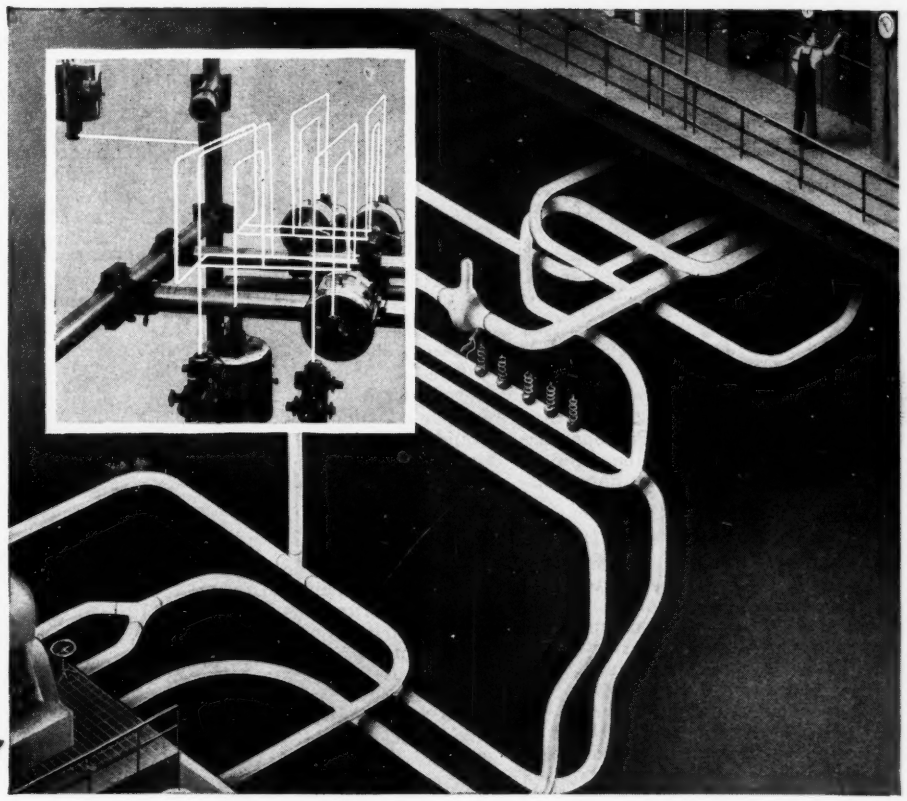

## Exclusive Equipment aids Seven New Power Installations

To be able to solve economically the exacting problems expected with the advent of future superpower stations, Kellogg's engineers and scientists some years ago began a search for a method of positively determining stresses and reactions in power piping.

Although the general mathematical method developed earlier by Kellogg is capable of solving problems of any complexity, the time required for computing the more intricate piping systems becomes impractical.

Here's what Kellogg eventually created—an exclusive, positive apparatus for accurate determination of stresses and reactions in the most complicated piping systems—a model tester, with specially-created and patented, electrical measuring heads.

Although this equipment was used on important work for the Navy during the war, the apparatus is now serving the purpose for which it was originally intended.

For example, with today's expansion and improvement in power generating stations, Kellogg has used the "tester" for analyzing the stresses in the re-heat steam cycle connections for the first two stations to operate on the re-heat cycle at 1000°F. Five additional proposed installations have been similarly studied, some of which will operate up to 1050°F. This makes a total of seven completed jobs with more "in the works" at the present moment.

Actual experience shows that the Kellogg Piping System Model Tester provides results that are borne out under actual operating conditions. Power engineers are able to take economic advantage of these analyses . . . permitting marked savings in material purchases.

The development of equipment such as this is another reason why Kellogg is enjoying so large a share of the critical, high-pressure, high-temperature piping business today.

If you are interested in further information on this advance in power piping design, Kellogg piping engineers will be glad to discuss it in detail with you.

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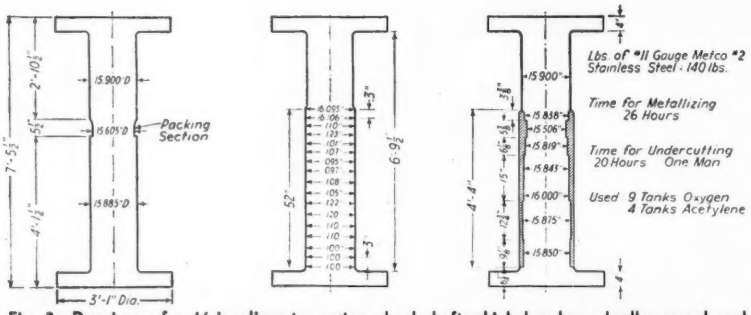
Packing Section
Lbs. of #11 Gauge Metco #2 Stainless Steel - 140 lbs.
Time for Metallizing 26 Hours
Time for Undercutting 20 Hours One Man
Used 9 Tanks Oxygen 4 Tanks Acetylene

Fig. 3. Drawings of a 16-in. diameter water wheel shaft which has been badly scored and corroded. Left, dimensions before metallizing; Center, after metallizing; Right, after regrinding to 16 in.

But what can metallizing do in a hydroelectric plant? Perhaps the best answer is to describe some of the work which is being done successfully.

### Water Wheel Runners

The most spectacular repair operation today is the repair of cavitated water-wheel runners. Fig. 2 shows a 1350-hp reaction type runner. This particular unit started out with cast iron buckets, which cavitated badly at the point where the buckets are attached to the lower rim. Replaced with cast steel buckets, the same thing occurred. More repairs were necessary and it was decided to metallize with stainless steel.

The best method developed for doing this type of work is quite interesting and highly successful. First, the honeycomb material is chipped out so that a fairly uniform surface remains. Edges of the chipped area are slightly dovetailed. Then, the areas are blasted with a G-16 angular steel grit using a pressure blast machine at about 100 psi. Blasting is carried 3 to 4 in. outside the edges of the chipped area whereever possible.

The depression is filled with the spray gun, using a medium-chrome, medium-carbon stainless steel. This material has been found to resist cavitation and abrasion much better than other metals. By checking the sprayed coating carefully, it is possible to bring the surface back pretty close to the original contour with the spray. About .050 in. should be allowed for grinding after spraying. Spraying is carried beyond the edges of the chipped area, but stopped inside the blasted section. It is tapered off to nothing as it approaches the unblasted sections.

To reach inaccessible parts of the bucket, the metallizing gun is equipped with an extension nozzle and angular air cap. The air cap directs the spray at an angle of about 45 deg. Outer sections near the rim are done without the extension.

Finishing is done with portable air or electric grinders. Here is where the original chipping operation, and care in spraying to original contour really pay off. If the honeycomb were not chipped out, the spray would build up as much over the high spots as in the low ones. Much more grinding would be necessary in that case.

So much for the method. It is significant that the company which developed this particular technique has been metallizing their cavitated water wheel runners ever since 1932. They are not only satisfied with the results of metallizing as stopping further cavitation, but have saved many many hours of labor as compared to the welding they had previously tried with only moderate success.

### Water-Wheel Shafts

Figure 3 comprises three drawings of a 16 in. water-wheel shaft which had been badly scored and corroded, particularly at the packing section. At the left, you see the dimensions before metallizing; in the center after metallizing; and at the right after regrinding to 16 in.

The shaft was mounted in a lathe and turned down enough to clean up entirely the pits and scored areas. Depth of cut varied from ⅛ in. along the journal to over ¼ in. at the packing zone. A stepped undercut was used, as shown in the right hand sketch, to save time and metal. After the cleaning cuts were completed, a square threading tool was ground to a width of .045 to .050 in. Corners were stoned to prevent fracture lines in the base. 14 threads to the inch were cut about .020 in. deep. Then, threads were knurled with a special type of knurling tool. This tool consists of 5 saw-like blades set with teeth staggered to produce a very irregular cut. Light passes were made to roughen the threads and roll their edges slightly, leaving dovetailed threads.

The shaft was sprayed with the same medium-chrome, medium-carbon stainless steel. Dimensions after spraying varied from 16.095 to 16.123 in., ample for finishing. The coating was roughed down with a cemented carbide tool and the final finishing done with a portable tool-post grinder. It was found that a coarse grain, low bond strength wheel did the work best, since sprayed metals tend to fill up ordinary wheels fairly rapidly.

This particular shaft, one of many which have been done, was inspected after two years of operation. It was found in excellent condition. The greatest wear at any point was .002 in. at the packing gland.

### Wicket-Gate Stems

Figure 4 shows a typical wicket-gate and long stem. One of a group installed in 1915, both the short and long stems were turned down and fitted with undersize bronze bearings in 1927. By 1944, they needed attention again. They couldn't be turned down any further because of the taper at the end of the long stem, so it was decided to metallize with stainless steel. Again the medium-chrome, medium-carbon stainless steel was selected since it is highly resistant to wear and at the same time would stand corrosive action.

Bearing surfaces only were turned down and prepared in much the same way as described for the water wheel shaft. In this case, however, a V-thread was used and then knurled with the same special tool. Bearing surfaces were built up to finish close to their original diameter, and the undersize bronze bushings bored out to fit. Thus, not only the wicket-

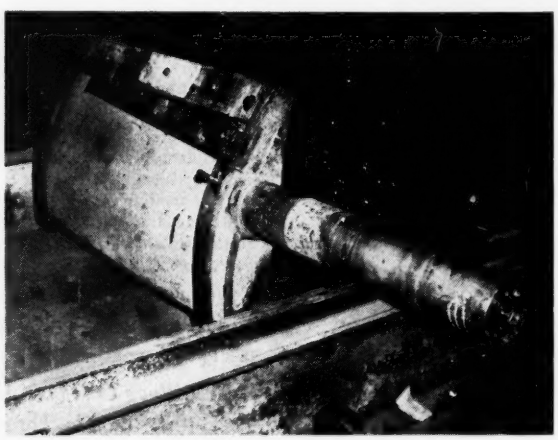

Fig. 4. Typical wicket gate and long stem

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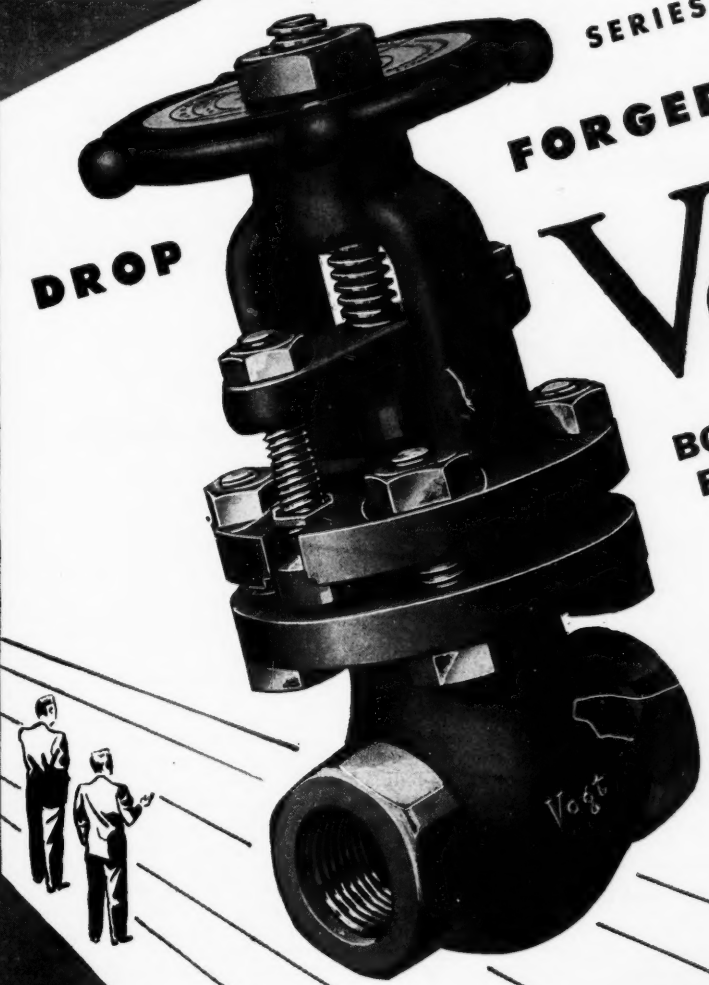


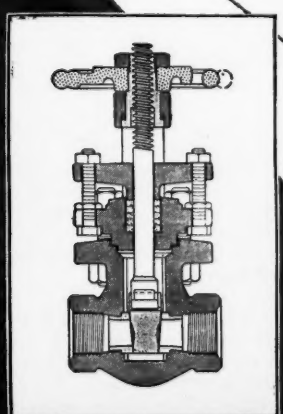

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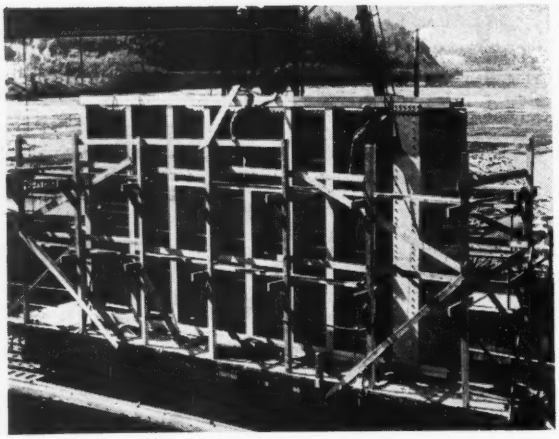


Fig. 5. A headgate in the process of being sprayed with zinc to prevent corrosion

gates were salvaged but a complete set of bushings as well.

#### Headgates

Figure 5 shows a headgate in the process of being sprayed with zinc to prevent corrosion. Here again, blasting is the method of preparation. However, the abrasive cannot be recovered and re-used, hence sand is selected instead of angular steel grit. The best sand for this purpose is a good grade of hard silica or flint, angular washed sand from 16 to 20 mesh size. Only as much surface should be blasted as can be sprayed within 4 hr. Two men working together, one blasting ahead of the other, can coat about 100 sq ft per eight hour day.

It has been found that a zinc coating entirely immersed tends to blister after a time. The cause is not entirely understood. Fortunately, however, the remedy is. After blasting carefully and thoroughly, about 0.001 in. of low carbon steel is sprayed over the blasted surface. This is a fairly fast operation since it is only a flash coat of steel, just enough to cover the area. Then 0.010 to 0.015 in. of zinc is sprayed over the steel undercoat.

Frequently the question is asked, "How do you get a uniform coating of zinc on such a surface?" First step is to lay out an area of, say 25 sq ft. Then, weigh out ½ lb of zinc wire to the square foot; in the example given, 12½ lb. Spray a light coating, passing from right to left and left to right across the surface. When the entire area is covered, apply a second coat, passing the gun up and down. Then, repeat the horizontal passes, and so on. By alternating coats with passes at right angles to each other, even an inexperienced operator will produce a remarkably even coating. After application, an accurate check can be made with an electric thickness gage. Light spots can be touched up without further preparation.

#### Conclusion

The above jobs are typical of the work being done with metallizing in Hydroelectric plants today. There are many others, of course, on pump parts, valve stems and the like. There can be no doubt that metallizing guns have come into their own as a means of repairing worn mechanical parts and stopping corrosion around hydro plants. Those who do not already use the process can well afford to look into it. Metallizing can well be the difference between a great deal of expensive outage and a much smaller amount. The repair of one water wheel runner usually pays for the cost of a metallizing installation.

A word to those who have metallizing equipment and who aren't using it. The reason they're not is undoubtedly because they tried a couple of jobs that didn't work out the way they wanted them to. The chances are also that that occurred quite a little time ago. Figure out why they didn't work. If others can do them successfully, you can too. Metallizing has come a long way in the last ten years.

# Electric Shock—
# Can Be Either Injury or Treatment

By DR. W. SCHWEISHEIMER

MOST CONSPICUOUS KIND of electric shock is death by lightning. After Benjamin Franklin had discovered the electric nature of the lightning stroke, another experimenter in this field, Richmann of St. Petersburg, was killed by an electrical discharge in 1753. Today, in the United States and Canada, the number of fatalities a year ascribed to electricity is seven per million of population. Approximately half of the accidents reported are fatal. In the utility field the number of deaths of employees ranges from 70 to 80 per year.

#### Effects of Electric Current on the Body

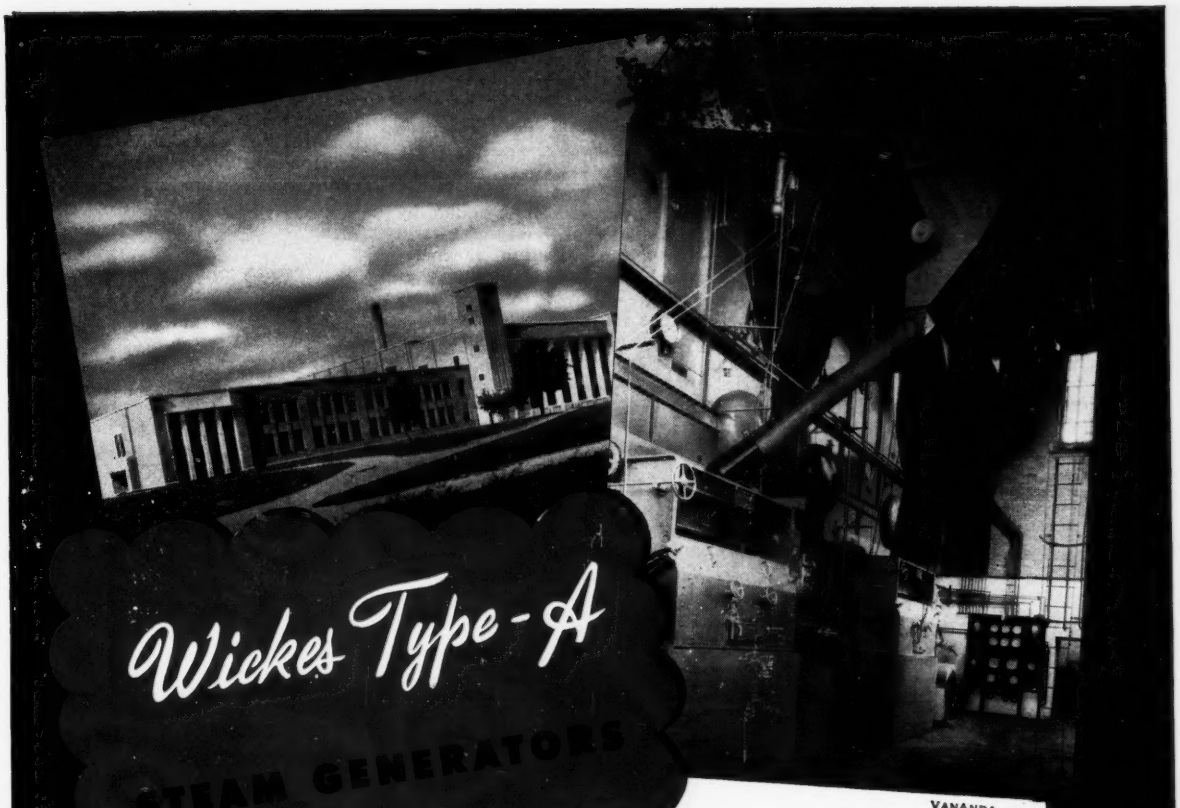
Passage of an electric current through the body produces numerous effects that differ both in intensity and kind; they range from a slight tingling sensation to death. Dr. W. B. Kouwenhoven, dean of engineering and professor of electrical engineering at the Johns Hopkins University, in a recent publication, has described these effects in detail. Muscular contractions are produced when contact is made with an electric circuit. At high voltage, the muscle spasm is very sudden and severe. It may throw the victim clear of the circuit, and in some instances bones have been broken. Such contractions of the limbs often are observed following a shock, and tremors (trembling) may continue for some minutes.

Electric shock therapy has been used by psychiatrists in the treatment of several mental conditions. Its comparative ease of application has always been seductive since it was first used in the treatment of mental diseases by Cerletti and Bini in Italy. It has been found most effective in the treatment of depressions, also in cases of dementia praecox.

In this method, according to Barrera and Kalinowsky, the patient's head is inserted in the electrical circuit at two points of contact where the electrodes are attached, usually at the sides of the skull. The electrical contact between electrode and scalp is intensified by application to the scalp of electrode jelly, and by wrapping the electrodes in gauze thoroughly saturated with concentrated sodium chloride solution. The duration of the shock ranges from 0.1 to 0.5 sec and the current from 200 to 1,600 milliamp. Number of treatments used for one patient varies greatly; on the average, a course of 12 shocks is being employed.

Various reports stress that the results of eletcric convulsive methods are practically equal to those obtained with insulin. Others claim that the results of the electric shock method are unsatisfactory. At any rate, early application of the method is most important.

There is no universally accepted theory which explains the value of electric shock in therapy. Kouwenhoven mentions that some speak of profound physiochemical changes in nerve cells, while others believe that the shocks form an acceptable pun-

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ishment, which relieves the patient of the feeling of guilt. Although this treatment is used so commonly, there are only a few cases of death following the shock. Permanent symptoms, due to damage to the brain, are rare.

### Dangers of Electric Shock Therapy

Still there seem to be certain dangers connected with the electric shock therapy. Lingley and Robbins report the results of a study on 230 patients whose convulsions lasted about 45 sec, during which the patient was held by five attendants. The attendants were experienced men and realized the importance of not holding the patient too rigidly. However, 53 patients, or 23 per cent, sustained fracture, predominantly of the vertebrae.

The incidence of fracture was greater in males than in females, and greater in the younger and older than in the middle-age groups.

A better insight into the mechanism of the electric shock has been given by Farraro, Roizin and Helfand. They showed that electric currents — which were similar in type, strength and duration with that used in human electric shock treatment — may cause changes in the central nervous system of monkeys. When a current of greater intensity and of longer duration is applied, occasional minute hemorrhages (bleeding in the brain) result. This seems to show that the severity of the lesion is proportional to the intensity of the electric current, the duration of the current flow and, to a lesser extent, to the number of electric shocks.

In the course of electric shock treatment, Tyler and Lowenbach gained the impression that patients who had an extended period of confusion after the treatment improved more readily than patients in whom this effect was absent. Thus they began to give shock treatments so closely that long-lasting confusion resulted. To produce such results, the patients had to be given up to four electric shocks per day, sometimes for several days in succession. The number of patients who recovered was hardly different from that found after other forms of shock therapy. The period of hospital treatment, however, could be shortened considerably by this method.

Electroshock is used for other disturbances as well. A. Pacifico, Naples, used electroshock in the therapy of enuresis of children (bed-wetting). In these cases the electrodes were placed over the second lumbar vertebra and the bladder. An electric current of 200 or 300 milliamp was passed for 0.1 sec. Shock therapy was given every other day up to a total of three or four. Enuresis was controlled from the first shock treatment in all cases with the exception of the patients with epilepsy. The treatment was well tolerated, according to the author, and the effect persisted for two months. (It may be mentioned that this is not the usual method for treating enuresis of children.)

### Temporary Paralysis by Electric Shock

The nervous system may be so profoundly shocked or fatigued by a contact with an electric circuit that it cannot function normally again for a period of minutes or hours. Kouwenhoven explains that, saying that the nerve cells are injured, especially in those parts that have been traversed by the current. He emphasizes the extreme importance of the pathway that the current traverses in its passage through the body.

In general, if there are no vital organs, such as the brain, the heart, or the lungs, in the current path, the resulting injury is a minimum one—burns excepted. For example, in Kouwenhoven and Landworthy's experiments on rats, in which the animals were given a 2-sec shock at 220 v, 60 cycles, all those where the current path was from foreleg to foreleg died; while those animals where the path was from hindleg to hindleg, survived.

In most industrial accidents, Kouwenhoven says, the current path is from the hands to the feet. This path involves the heart and the lungs and is, therefore, particularly dangerous. When contact is made at two points on the same arm or leg, no current passes through the trunk. Once the current enters the body, it follows a more or less fusiform pattern. When through-type current transformers were inserted in the body, Kouwenhoven, together with his coworkers Hooker and Langworthy, found that approximately 10 per cent of the total current passed through the heart when the current pathway was from one hand to the feet.

One of the most common effects on the nervous system is the production of a temporary paralysis or block. The location of this block will depend upon the path taken by the current. Kouwenhoven ascribes the many successful resuscitations, after prompt application of artificial respiration to shock victims, to the temporary nature of the paralysis. If nature is given the opportunity, it often will repair the damage and again permit the signal from the brain to reach the organ which was temporarily paralyzed.

## CURRENT TOPICS

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And I know WATT'S WATT;
I know my POWER,
Boy, am I HOT.
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An OHM, SWEET OHM.
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I can SWITCH
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If I get the itch.

---

A BURNING PAPER match is said to provide one candle-power or about 1/20 of the light produced by a 25 watt incandescent light bulb. Westinghouse engineers point out, however, that the match's glow produces 40 times more light than the "grain of wheat" lamp used by surgeons to explore the interior of the body.

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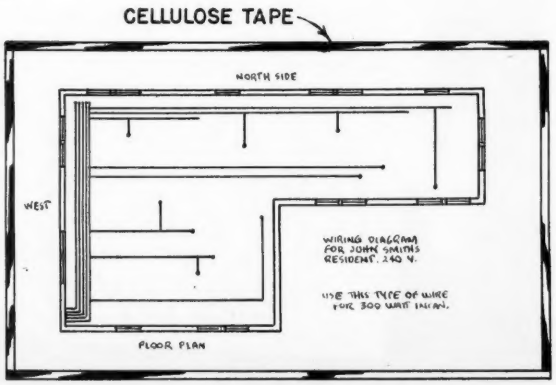
## BLUEPRINT PROTECTION

**By Thomas Trail**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BLUE PRINT

Cellulose tape applied to the edge of a blueprint or wiring diagram, as shown in the accompanying sketch, will help prevent the edges from becoming torn and the corners damaged

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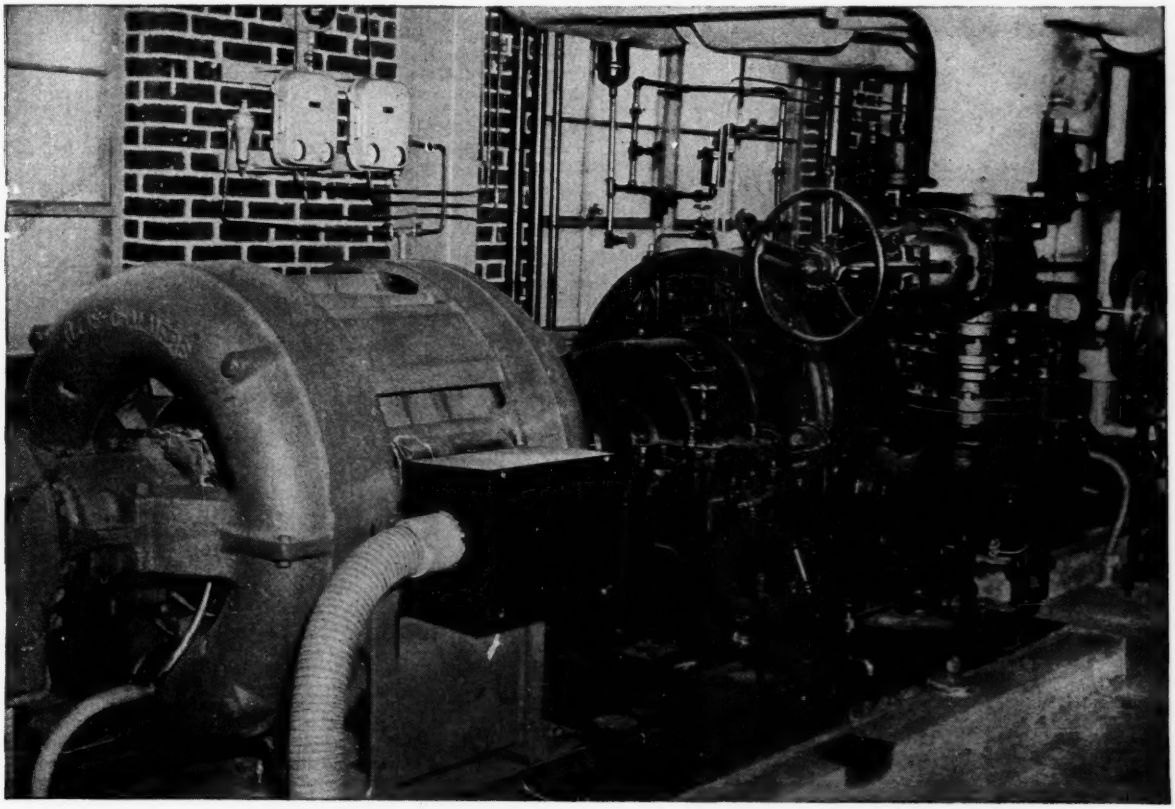

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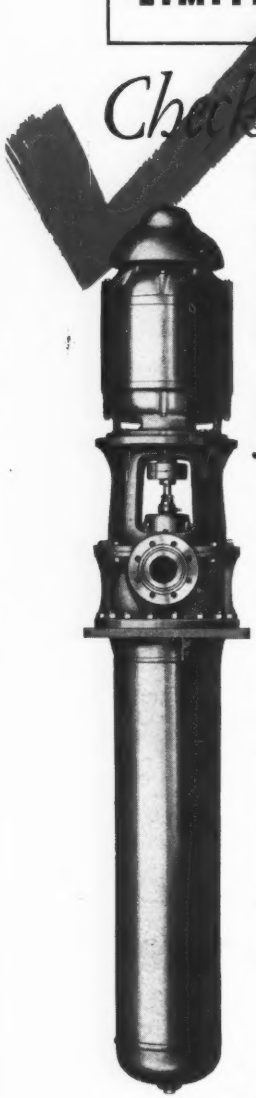

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V-3

# POWER PLANT *Construction News*

**Los Angeles, Calif.**—Los Angeles Board of County Supervisors, Hall of Records, plans installation of boiler plant for central-heating in new one and multi-story hospital for contagious diseases. Entire project is estimated to cost about $4,500,000. A bond issue is being arranged in that amount. Paul R. Williams, 3747 Wilshire Blvd., and Adrian Wilson, 816 Fourth St., Los Angeles, are architects.

**Rocky Ford, Colo.**—Southern Colorado Power Co., Pueblo, Colo., has approved plans for new steam-electric generating station at Rocky Ford, reported to cost about $2,000,000. Work is scheduled to begin soon.

**Panama City, Fla.**—Standard Oil Co. of Kentucky, Inc., 426 West Bloom St., Louisville, plans boiler plant and pumping station at proposed new bulk oil terminal and canning plant on waterfront at Panama City. Entire project is reported to cost in excess of $500,000. Work will be placed under way at early date.

**Rock Island, Ill.**—Iowa-Illinois Gas & Electric Co., has concluded financing in amount of about $10,000,000, proceeds to be used in part for expansion and improvements in power plants and system. This is part of a general development program approved by company over a period of several months.

**Natchitoches, La.**—City Council has authorized expansion in municipal power station, using Diesel engine-generator unit, with installation of new generator of similar type and auxiliary equipment. Cost estimated about $400,000. A bond issue in that amount is being arranged.

**Norfolk, Mass.**—State Department of Correction, Boston, Mass., plans steam power station for central-heating service at new State Prison at Norfolk. Entire project to cost close to $3,400,000. Erection is scheduled to begin soon.

**Detroit, Mich.**—Detroit Edison Co., 2000 Second Ave., will carry out a 48-month expansion and improvement program in plants and system, estimated to cost about $142,000,000 in that period. Work will include extensions in generating facilities, transmission lines, power substations and other operating facilities.

**Cedar, Minn.**—Minnesota Cooperative Electric Association, Cedar (Anoka County) plans new Diesel engine-generating station on local site, reported to cost about $200,000. H. E. Edmund is president.

**Moorhead, Minn.**—Minnesota Farm Bureau Service Co., 101 East Fairfield Ave., St. Paul, Minn., plans boiler house at new commercial fertilizer plant at Moorhead, where site has been acquired. Entire project will cost approximately $350,000. Toltz, King & Day, Inc., Pioneer Bldg., St. Paul, is engineer.

**Jefferson City, Mo.**—Missouri Power & Light Co., 106 West High St., will carry out expansion in generating facilities in connection with an expansion and improvement program in plants and system, estimated to cost about $16,000,000. Plans have been approved and certain financing is now being arranged.

**Newburgh, N. Y.**—Central Hudson Gas & Electric Corp., Poughkeepsie, N. Y., has plans in progress for new steam-electric generating station on Hudson River, vicinity of Newburgh, with initial capacity of 60,000-kw. Cost estimated close to $12,000,000, with transmission lines, power substations and other facilities. Burns & Roe, 233 Broadway, New York, N. Y., are consulting engineers.

**North Wilkesboro, N. C.**—City Council plans central-heating plant in new hospital on local site, entire project to cost about $1,200,000. It is understood that bids for erection will be asked early in 1950. J. N. Pease & Co., 119½ East Fifth St., Charlotte, N. C., are architects.

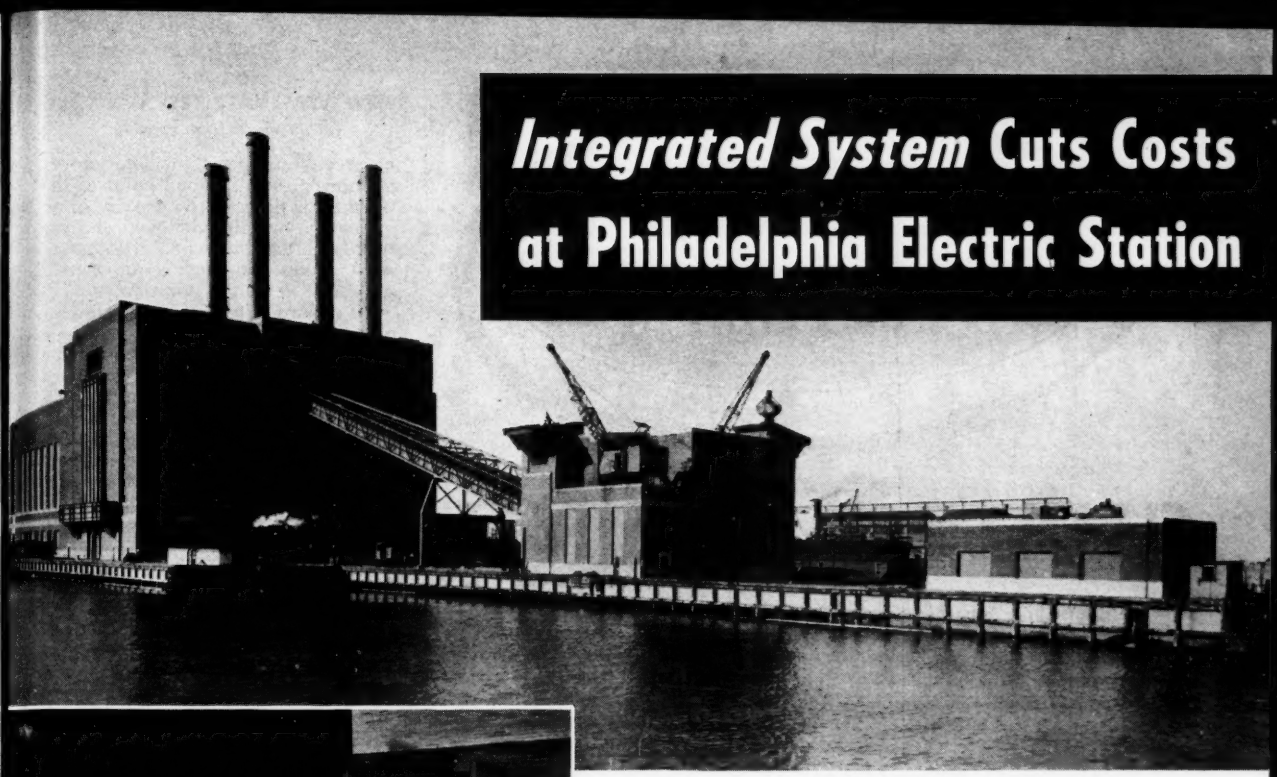
**Chillicothe, Ohio**—Columbus & Southern Ohio Electric Co., Columbus, Ohio, has plans maturing for new power substation near Scioto River, Chillicothe, reported to cost approximately $500,000, with transformers, switchgear and accessory equipment.

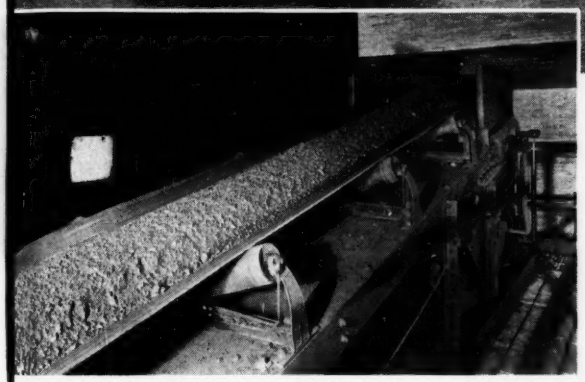
**Perry, Okla.**—Town Council plans extensions and improvements in municipal Diesel engine-operated power plant, including installation of additional equipment. Cost about $190,000. Bonds in that amount have been authorized.

**Bellefonte, Pa.**—West Penn Power Co., 14 Wood St., Pittsburgh, Pa., has work under way on steel frame super-

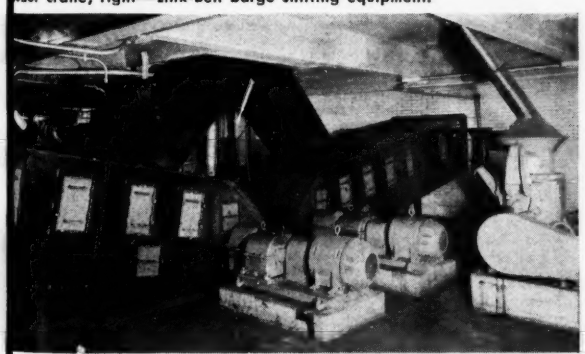
*(Continued on page 121)*

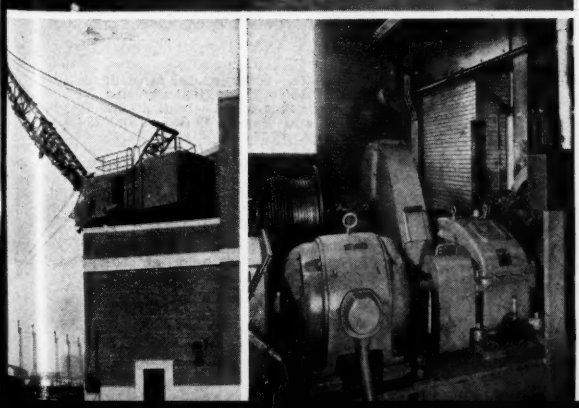
# *Integrated System* Cuts Costs at Philadelphia Electric Station





ve: Belt conveyor delivering coal to storage bunker. In center: Foot-end belt conveyors showing speed reducer drives. Below: left—Link-Belt ader crane; right—Link-Belt barge shifting equipment.





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From the bottom of each 55-ton unloading hopper the coal passes to a short inclined steel apron feeder which discharges to a Bradford breaker. The 1 ½" minus coal from the breakers passes to the main belt conveyors, from these to a system of belt conveyors by which the coal is weighed and delivered to the bunkers. An emergency system for receiving coal from R.R. cars is also provided.

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## NEW VERSENATE TEST

*(Continued from page 74)*

no precipitate forms, the solution remaining clear. The end point of the titration is detected by the use of an indicator, which changes sharply from red to blue when the last of the calcium and magnesium is tied up by the versenate solution.

To make the test, a 50-ml sample† of the water being tested is placed in a 250 ml flask with 4 drops of the hardness indicator and 1 ml of a concentrated buffer solution to hold the pH around 10. The color of the mixture will be red. Standard versenate solution is then run in from a burette until the color changes from red to a pure blue. The volume of standard versenate required to cause this change is multiplied by 20 to give the total hardness in parts per million. Figures 1 to 4 show the simple steps in the process.

Experience with this method to date indicates that it is superior to the soap method, both in accuracy and speed, and equal in accuracy to the time consuming soda reagent method. Hardness has been determined with the versenate method on waters having a hardness as high as 1400 ppm. The standard solution is quite stable. The necessary apparatus and reagents are readily available and are relatively inexpensive.

† 1 ml = 1 milli-liter = 1 cc, to a very close approximation, accurate enough for most practical work.

As this goes to press, additional information on this test has just been received from several of the major water treating companies. This includes some modifications of the test whereby calcium and magnesium hardness may be determined, as well as total hardness. It will be published in a subsequent issue.

Versenate is, of course, a trade name, it is the disodium salt of ethylene diamine tetra-acetic acid. It is sold under the trade names of Trilon-B, Nullapon, Immol-D, Versene, Sequestrene, and perhaps others.

## COMING EVENTS

**NSPE**—A generous share of Texas hospitality is assured for the delegates to the Annual Meeting of the National Society of Professional Engineers at Houston, December 8, 9 and 10, General Arrangements Chairman, Mason G. Lockwood, has announced.

**AAAS**—American Association for Advancement of Science Annual Meeting to be held at the Pennsylvania Station zone hotels, New York, Dec. 26-31.

**ASCE**—The American Society of Civil Engineers will hold its annual meeting at the Hotel Commodore, New York, Jan. 18-20.

**ASHVE**—The 56th annual meeting of the American Society of Heating and Ventilating Engineers will be held at the Hotels Adolphus and Baker, Dallas, Jan. 23-26.

**AIEE**—The Winter General Meeting of the American Society on Electrical Engineers will be held at the Hotel Statler, New York, Jan. 30-Feb. 3.

**MPC**—The twelfth annual Midwest Power Conference will be held at the Hotel Sherman, Chicago, April 5-7.

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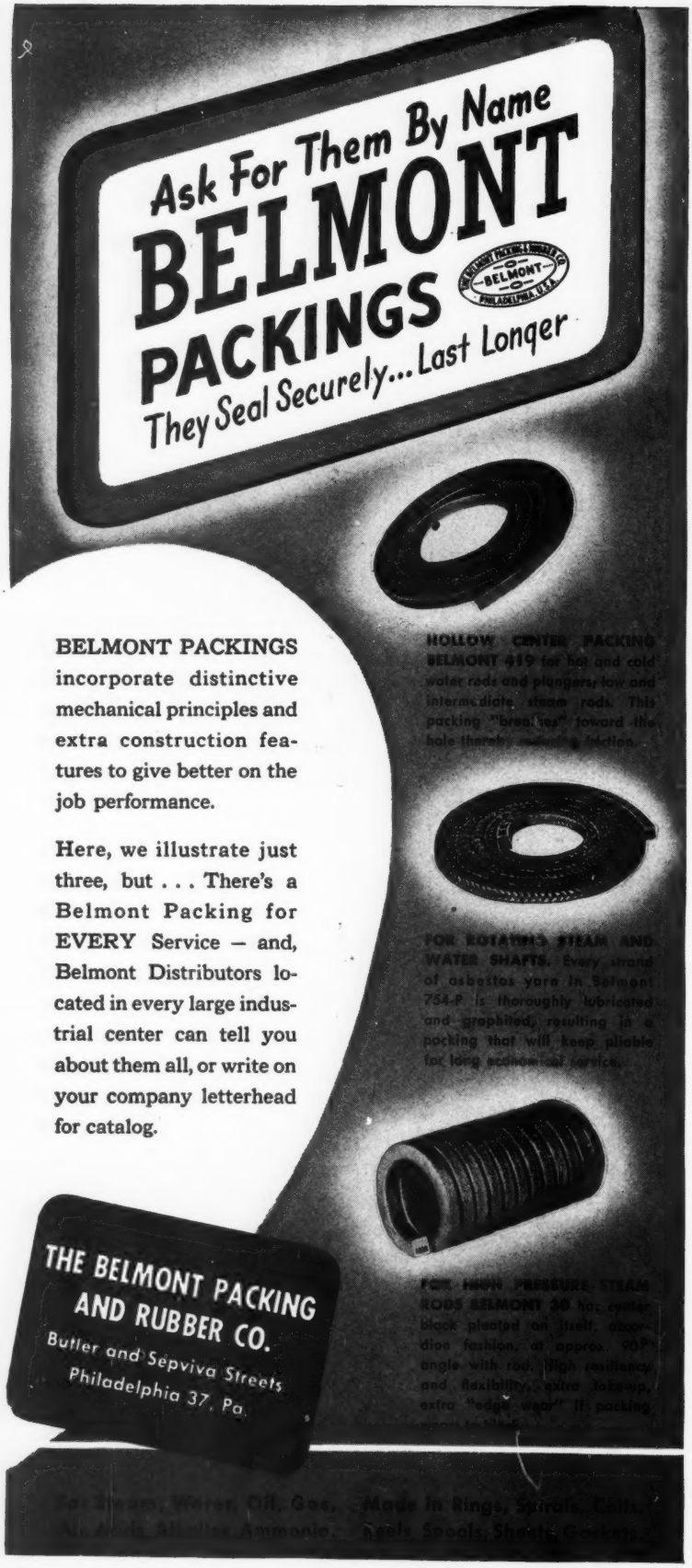
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# New ENGINEERING BOOKS

**Radioactive Tracer Techniques.** By Geo. K. Schweitzer and Ira B. Whitney. First edition, 6 by 8½ in., 241 pages, illustrated, colth. Published by D. Van Nostrand Company, Inc., 250 Fourth Ave., New York. 1949. Price $3.85.

This is a manual designed to serve as a guide for laboratory work and instruction in the utilization of radioactive tracers. It should be of value to all who may have use for radioactive isotopes as tracers in industrial or medical applications.

The first four chapters are fundamental because they deal with topics which are pertinent to all radioactive laboratory work. These chapters should be useful in giving the prospective user of radioactive material the basic knowledge he needs before he undertakes to handle it.

Basic experiments are presented in chapter 5. This division contains seven experiments dealing with methods and peculiarities of radioactivity measurements and properties of radioactive substances. The remainder of the book is devoted to material illustrating chemical, physical, and biological tracer methods. The final chapter discusses special preparations. An appendix of general information is provided also.

The experiments have been planned so that they require only the most easily available radioactive materials. The necessity for the preparation of special radioactive solutions has been held to a minimum.

Geo. K. Schweitzer is assistant professor of chemistry at the University of Tennessee, Ira B. Whitney is chief supervisor, Radio Chemical Process Development, at the Oak Ridge National Laboratories.

• • •

**Introduction to Atomic Physics.** By Henry Semat. Revised and enlarged edition. 412 pages, 6¼ by 9 in., illustrated, cloth. Published by Rinehart & Company, Inc., New York, N. Y. 1949.

Curiously enough, this excellent book on atomic physics was first published in 1939 just as the formal military phase of World War II was about to begin. People who, today, date the beginning of the atomic age from the dropping of the bombs on Hiroshima or as far back perhaps as the beginning of the war would be surprised to learn from this book, how much was known about atomic physics in 1939. That year, as a matter of fact, ended a period of seven years of brilliant development. That period saw the discovery of three new fundamental particles — the neutron, the positron, and the meson. The meson theory, incidentally, had been initiated by a Japanese scientist, Yukawa. This period also saw the discovery of several new phenomena such as induced radioactivity, the materialization of energy by the transformation of a photon into two charged particles, and its converse, the annihilation of matter by the combination of positrons and electrons to form photons.[1] During this period, that is, from 1932 to 1939, work was begun on the production of transuranic elements which finally culminated in the discovery of nuclear fission. As pointed out by the author of this book, under normal conditions, one could have expected tremendous advances in the fundamental aspects of atomic physics after such a remarkable period of discovery.

These advances did not transpire, however. The brilliant period came to an abrupt end with the beginning of the military phase of World War II when scientists became almost exclusively concerned with the application of concepts and ideas already known to particular problems of military importance. Undoubtedly some work was done on fundamental problems, but most of it is still shrouded in the secrecy of military security. Part of this secrecy was rent in dramatic fashion by the explosions of the atomic bombs over Hiroshima and Nagasaki.

With the end of the military phase of the war, scientists left their wartime tasks and returned to their experimental laboratories. Many baffling problems, particularly in nuclear physics still await solu-

[1] See Nuclear Power Engineering, Part IV, *Atomics*, September 1949. Page 11.

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tion. Large quantities of a new element, plutonium, and many new radioactive isotopes of the more common elements have been produced as a consequence of the more outstanding work of the atomic bomb project. These should be available in the near future for the solution of problems in nuclear physics and in the other sciences as well.

The point that should be clearly understood, however, is that though this book has been brought up-to-date to include the developments since 1939, the basic material which constitutes the bulk of the book was very well known in 1939.

As is to be expected, the major changes in this revision have been made in the section on the Nucleus. Not only have the data been corrected and brought up-to-date, but many of the topics have been given more extensive treatment—the production of transuranic elements, the fission of nuclei, and nuclear isomers. Several new topics have been added—the discovery of new elements, sources of nuclear energy, and the measurement of nuclear magnetic moments. The betatron, one of the outstanding developments of recent years is considered in considerable detail both as to its operating principle and use as a tool in physics.

It is an excellent book for the beginner in atomic physics. Basically, it represents the content of a one-semester course which the author gave in the decade beginning in 1931. Divided into three main divisions, the first division presents the foundation of atomic physics—the elements of electricity and magnetism, elementary charged particles, electromagnetic radiation, waves and particles.

The second division considers the extra-nuclear structure of the atom—the hydrogen atom, atomic spectra and electron distribution.

Division three is devoted to a discussion of the nucleus. This takes up the subject of natural radioactivity, the disintegration of nuclei and nuclear energy in general.

The latter part of the volume contains tables of various physical constants, atomic weights, tables and isotopes, etc.

• • •

**Introduction to Radiochemistry.** By Gerhart Friedlander and Joseph W. Kennedy. First Edition, 412 pages, 6 by 8½ in., cloth, illustrated. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 1949. Price $5.00.

This book describes the nature and applications of radioactivity without assuming previous knowledge of nuclear physics. It begins with a brief discussion of the historical background which is used as an introduction to the concepts and terminology treated later. Also included in the early chapters is descriptive information about atomic nuclei, nuclear reactions, and the apparatus used for the acceleration of nuclear projectiles.

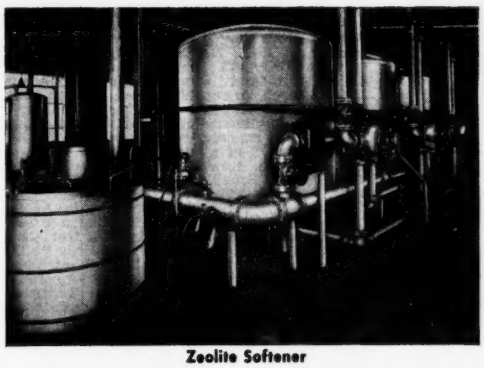
Later chapters introduce in logical sequence the quantitative treatment of radioactive decay processes, the various types of radioactive disintegration, the radiations emitted, their interaction with matter, and their detection. One chapter is devoted to the statistical treatment of radioactivity data, another to the useful techniques in the study of radioactive radiations and in the final chapters the applications of radioactivity to chemistry are treated. The use of the term, **radiochemistry** should not mislead anyone to feel that this book is concerned with chemistry in the usual sense. The authors feel that the term nuclear chemistry emphasizes the reactions of nuclei and the properties of resulting nuclear species, just as organic chemistry is concerned with the reactions and properties of organic compounds. In the title of the book, the authors have meant the term radiochemistry to include all types of nuclear reactions but excluding stable isotope tracer reactions.

Of considerable value is the list of radioactive and stable isotopes of the elements given in the appendix. This list, involving 89 pages, gives the atomic number, symbol and mass number, the per cent abundance, isotopic mass, half-life, modes of decay and modes of formation of all the known isotopes.

Another valuable feature of the book are the lists of references and the exercises at the end of each chapter.

The book is an outgrowth of an introductory course in radiochemistry first given in the informal Los Alamos University in the latter part of 1945 by the authors (principally C.F.) with the help of Drs. R. W. Dodson, and A. C. Wahl, and offered each year since in the Department of Chemistry at the Washington University at St. Louis.

Regarding the authors, Gerhart Fried-



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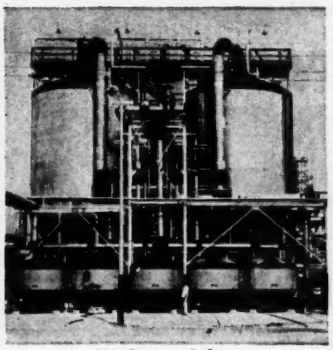

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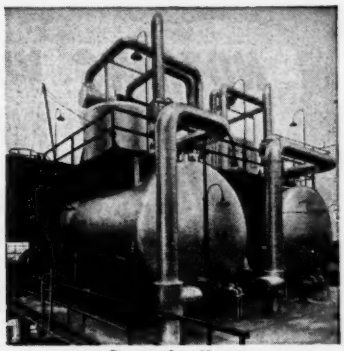

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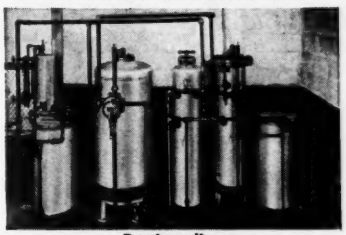
Reactivator Cold Process Unit



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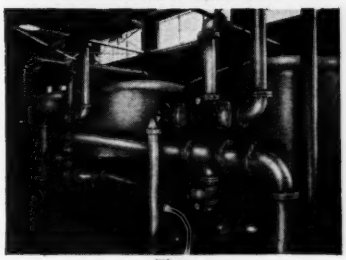

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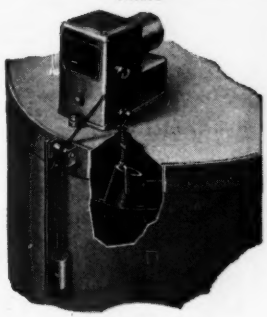

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lander received his B.S. degree in chemistry from the University of California at Berkeley in 1939, and his Ph.D. from that University in 1942. He taught radiochemistry at the University of California and at Los Alamos, and has worked in radiochemical research since 1938. From 1946 to 1948 Dr. Friedlander was in the research laboratory at the General Electric Company and worked on nuclear reactions induced by high-energy x-rays with the G. E. 100-Mev betatron. Te now holds the position of Chemist at Brookhaven National Laboratory.

Joseph W. Kennedy received his A. B. degree from the Stephen F. Austin State Teachers College in 1935, his M.A. from the University of Kansas in 1937, and his Ph.D. from the University of California at Berkeley in 1939. He has worked in the field of radiochemistry since 1937. Dr. Kennedy collaborated with three other scientists in the discovery of plutonium and the early study of its chemical and nuclear properties. From 1943 to 1946 he was division leader of the Chemistry and Metallurgy Division at Los Alamos. Since 1946 he has been Professor of the Chemistry Department at Washington University where he supervised the construction and operation of the Radiochemistry Laboratory.

• • •

**Nuclear Forces.** By L. Rosenfeld. 562 pages, 52 illustrations, size 7¼ by 10¼, cloth. Published by Interscience Publishers, Inc., 215 Fourth Avenue, New York, N. Y., 1949. Price $12.50.

This book was originally published in two volumes, but now this one volume edition has been made available. It is a most comprehensive book but decidedly not a book for the beginner or casual reader. Originating from an attempt to survey available empirical data on various properties of nuclear systems and derive from it unambiguous information on the character of special nuclear forces, this book is a critical survey of different aspects of nuclear research and a critical evaluation of methods, concepts and data.

The discussion begins with a consideration of the general features of nuclear forces and the properties of elementary particles. It takes up the question of nuclear radii, mass defects, and the charge dependence of nuclear forces. This constitutes Part I.

Part II begins with a discussion of nuclear systems, energy states of such systems, and interaction between particles in the nucleus. Part III considers nuclear models, the saturation of nuclear forces and the properties of light nuclei. Part IV takes up non-central and non-static couplings and the properties of heavy nuclei. The book concludes with appendixes, author and subject indexes, Tables of atomic nuclei and references.

In short, the author, who is Professor of Theoretical Physics at the University of Manchester and formerly Professor at the University of Utrecht, Holland, has written a work of herculean proportions and his work will be valued by physicists throughout the entire world.

• • •

**Foundations of Nuclear Physics.** Edited by Robert T. Beyer. First Edition. 139 pages + 117-page bibliography, size 6½ by 9½, illustrated. Published by Dover publications, Inc., 1780 Broadway, New York, N.Y., 1949. Price $2.95.

Nearly everybody who has some technical or even general interest in modern physics has heard of certain outstanding discoveries which underlie the startling developments in atomic physics during recent years. Thus, we have heard of Hahn and Strassman's discovery of uranium fission, of the discovery of the neutron by Chadwick and we know something about cyclotrons and we have heard of an entity called the meson. To nuclear scientists all of these things are commonplace, they can give you detailed accounts of the discoveries and developments. To most of us, however, they are mere events we come across in the literature, sometimes with brief supporting explanation but more often merely as a reference. Whatever further information we might like to have in regard to these things, few of us, unless it is vital in connection with some project we might be concerned with, go to the trouble of looking for such further information in the scientific literature. Most of us do not have access to this kind of literature.

It may be of considerable interest to many, therefore, to know of this new book which has been compiled by Dr. Beyer, who is assistant Professor of Physics at Brown University, for this book not only presents the original papers describing these great discoveries but presents them in facsimile, as they first appeared. In all,

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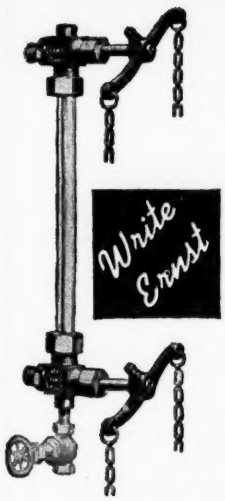


Fig. 5

Standard Vertical bronze water gage 350 pound design heavier construction up to 450 lbs., Stainless and forged steel for higher pressures.

Fig. 8

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Fig. 8SS Same fittings made in stainless steel.

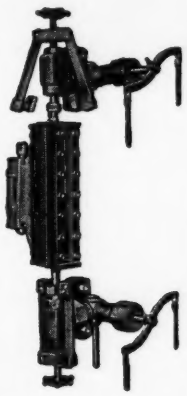

Fig. 72

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Fig. 1

High and Low Alarm Column equipped with Split-Gland Type Adjustable Inclined Water Gage

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Fig. 13

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Fig. 15

250 lb. pressure bronze, with iron weight double chain pull.

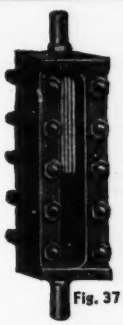

Fig. 37

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Fig. 45

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Fig. E-57 Bulls Eye Type

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Fig. 31

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Fig. 10

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Fig. 21 LIP MOLD RUBBER GASKET

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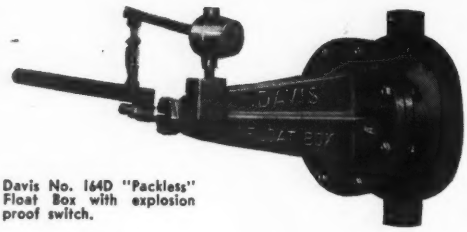


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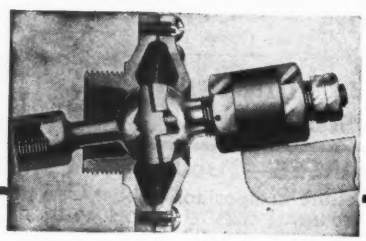

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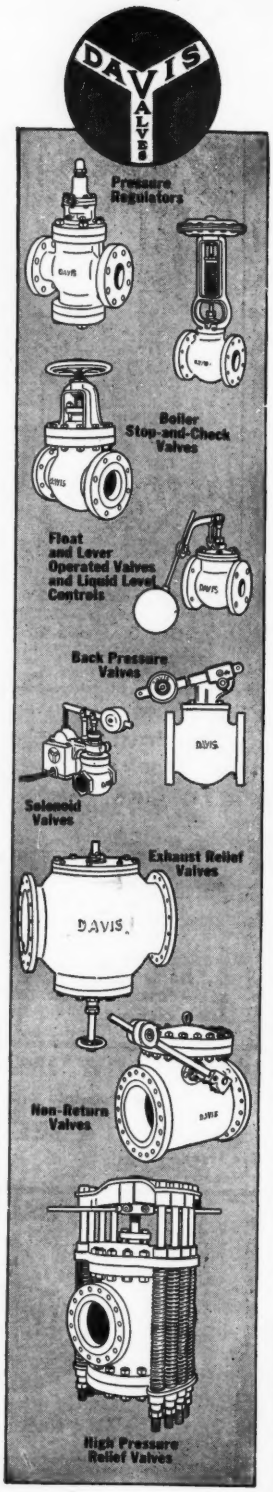


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there are thirteen fundamental studies as they were originally presented in the scientific journals.

Here are the papers in the order of their presentation:

1. Carl. D. Anderson; The Positive Electron
2. J. Chadwick. The Existence of a Neutron
3. J. D. Cockcroft and E. T. S. Walton. Experiments with High velocity positive ions. II. The disintegration of elements by high velocity protons
4. Mme Irene Curie and M. F. Joliot. Physique Nucleaire—Un nouveau type de radioactivite
5. E. Fermi. Possible production of elements of atomic number higher than 92.
6. E. Fermi. Versuch einer Theorie der B-Strahlen
7. R. Frisch and O. Stern. Uber die magnetische Ablenkung von Wasserstoffmolekulen und das magnetische Moment des Protons 1.
8. G. Gamow. Zur Quantentheorie des Atomkernes
9. O. Hahn and F. Strassmann. Uber den Nachweis und das Verhalten der bei der Bestrahlung des Urans mittels neutronen entstehenden Erdalkalimentalle
10. E. O. Lawrence and M. S. Livingston. The production of high speed light ions without the use of high voltages.
11. E. Rutherford. The scattering of alpha and beta particles by matter and the structure of the atom
12. E. Rutherford. Collision of alpha particles with light atoms, Part V. An anomalous effect in nitrogen.
13. Hideki Yukawa. On the interaction of elementary particles 1.

Few can disagree with Dr. Beyer in the selection of these papers. True some others might be added but within the limits set by the size of the book, Dr. Beyer has certainly included all of the most famous papers. It is an excellent job and the book should be of value and interest to all who value the historical view of an human endeavor. To thumb through the pages of this book is an arresting experience for the mature physicist. He will pause and reflect on the passage of time, recalling that it seemed only yesterday when certain of these papers appeared in current journals. He will be startled to contemplate the crude and simple apparatus with which some of these great discoveries were made. When he reads of Lawrence's first small cyclotron and mentally compares it with the 184-inch cyclotron now in operation at Berkeley or the 110-ft unit in course of development he will realize more than ever the speed of the progress of science in the last few years.

To the youngster in physics, this book will provide the historical perspective he needs for the development of his scientific consciousness.

The extensive bibliography which Dr. Beyer has assembled at the end of his book is one of the most comprehensive ever produced and accordingly very valuable. It is divided into 12 catagories and furnishes the scientist with the key to almost 5000 articles and journals.

● ● ●

**Physics in the Modern World.** By Henry Semat. First edition, 434 pages, 6½ by 9¼ in., illustrated, cloth. Published by Rinehart & Company, Inc., New York, N. Y., 1949.

Science is many sided in its appeals to various groups in our social structure for diverse reasons. Its appeal and value to scientists and technical groups is too obvious to need any discussion—members of these groups absorb scientific knowledge as a matter of course. There are other groups, however, non-scientific groups which also have an interest in science because of their concern with the practical applications of scientific principles. Some of these practical applications take the form of the production of instruments, chemicals, etc., others provide for man's leisure enjoyment such as radio, television, motion pictures and photography, greater scope in travel.

This, however, is only one aspect of popular science; a more important aspect of science is its continual challenge to the individual intellect that is seeking to understand the universe. The study of science is an increasing body of positive knowledge with continually expanding frontiers can be very exciting and very stimulating. It is to those whose interest in science takes this form that this book by Dr. Semat is addressed.

Dr. Henry Semat is associate professor of physics at The City College at the College of the City of New York. For over twenty years he and his colleagues have been experimenting with courses in science designed specifically for the non-scientific students.

This new book contains the material covered in the first of these courses.

## HELPFUL BULLETINS

*(Continued from page 36)*

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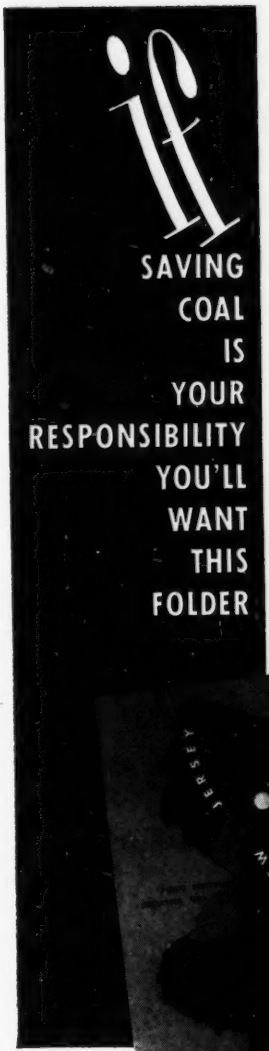


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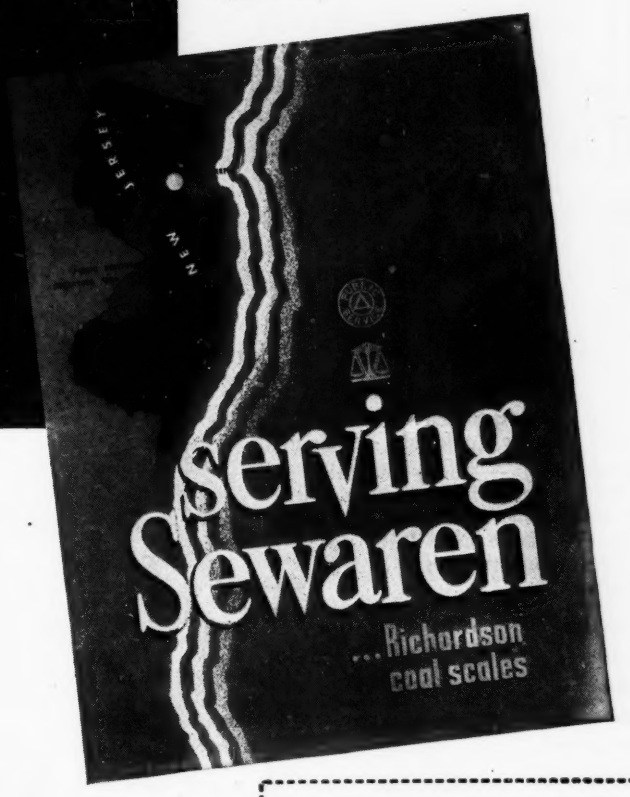


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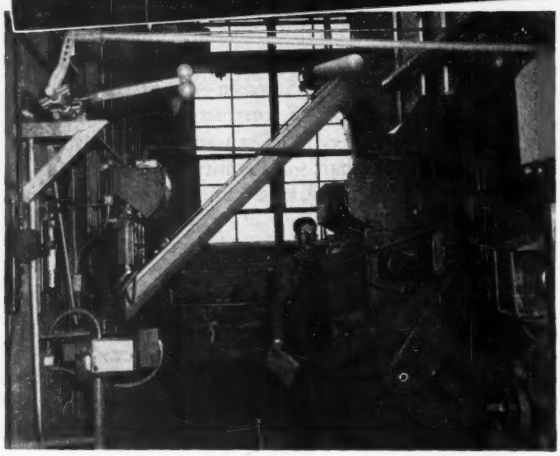

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## BOILERS AND AUXILIARIES

**201** **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

**202** **Blast Furnace Gas Burner Bulletin** —Said to be the first published on the subject. Bulletin No. 500, 4 pp, describes operation of these burners and discusses their adaptability for use not only with waste fuels, but also in combination with auxiliary fuels and by means of auxiliary fuels alone. Contains pictures of gas burner installations and cross section drawings of various other types of burners for waste and primary fuels. Peabody Engineering Corp.

**203** **Water Tube Boilers**—This 12-pp bulletin illustrates and describes special and standard power plant boilers and packaged steam generators. Includes data and dimensions. Springfield Boiler Co.

## VALVES, TRAPS, PIPING

**204** **Pipe Distribution System Data** — "Engineering Distribution Data for Underground Steam Distribution," is the title of Section 480-2, 34 pp, of practical usefulness to those who deal with problems involved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

**205** **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

**206** **Steam Specialties**—Here is a collection of bulletins covering manufacturer's line of thermostatic steam traps, inverted bucket steam traps, float-thermostatic steam traps, radiator traps and

valves, alternating receivers and lift traps, self-operated temperature regulators, air venting equipment, water blenders, strainers. All equipment is illustrated by photos, its operation and applications discussed, and its capacities, dimensions and prices listed. Sarco Co., Inc.

**207** **Pipe Hanger Catalog** — Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

**208** **Valves Bulletin**—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

**209** **Rubber Expansion Joints** — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

**210** **Control Equipment**—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

**211** **Flanges for Severe Service** — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

## HEATERS, HEATING

**212** **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

**213** **Space Heaters**—Bulletin 523, 12 pp, covers forced air space heaters, direct-fired by oil, gas or combination fuel and ranging in output from 400,000 to 2,000,000 Btu, for comfort heating, year-round ventilating, tempering make-up air, process drying and heat curing. It discusses their design and principle of heat distribution and lists 18 reasons why these heaters are recommended for open space heating. Includes specifications, capacity and dimension tables, sketches illustrating operating principles and construction details and photographs showing the heaters in use. Dravo Corp.

**214** **Packaged Heat** — Unit heaters featuring low first cost, easy installation and continued low cost per Btu are presented in this 12-pp booklet. Text explains how these packaged heaters are designed to operate instantly on oil or gas, fit heat output to requirements of day, and provide heat where it's wanted. Illustrations include photos of heaters and several installations and many sketches showing advantages and construction details. Prat-Daniel Corp.

**215** **Tubular Heat Exchangers**—Bulletin 916, 32 pp, is highly informative. The bulletin describes the present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

**216** **Chemical Soot Removal** — Ten-pp Bulletin 43, on the chemical removal of soot from boiler furnaces, explains the research work that led to the development of manufacturer's new chemical soot remover and slag alleviator for coal fired boiler furnaces. It tells how this combustion catalyst prevents soot formation on furnace internals and helps to end the smoke problem. National Aluminate Corp.

**217** **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

**218** **Tubular Heater**—A simplified vertical tubular heater suitable for every process duty and designed to hold initial and maintenance costs to a minimum, is the subject of 4-pp Bulletin 0-49-7. Includes a complete description of this sim-


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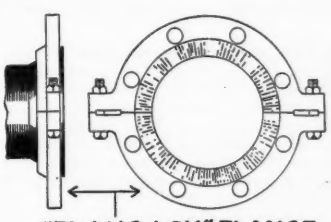

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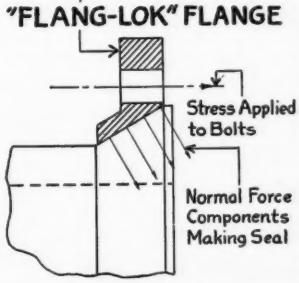


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plified design which features the use of bare tubes and the absence of any metal parts exposed to furnace gases, also a discussion of the design's advantages. Cutaway drawings illustrate text. Foster Wheeler Corp.

**219** **Condensate Drainage Control** — Manufacturer's system of high-pressure and high temperature condensate drainage control is fully explained in 24-pp Publication No. 3250. Contains useful data on steam flow conditions and heat exchange characteristics. Gives material and operating specifications and capacity ratings for both standard and high differential units in six sizes from 3 to 25 hp based on a maximum of 200 psi above process pressure. Differential pressures to 200 psi are listed and capacities for each unit tabulated for unit inlet pressures. Illustrations include photographs and dimensional drawings in color showing design and construction of both types of units. Cochrane Corp.

## TREATMENTS, PREVENTIVES

**220** **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

**221** **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

**222** **Corrosion Resistance of Nickel Alloys** —Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 86 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

**223** **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

**224** **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

**225** **Boiler Corrosion**—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

**226** **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 28B7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurence data on compounds found, composition of turbine deposits

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from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

**227** **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

**228** **Water Softener Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners and includes detailed, illustrated discussion of multiport valves used in them. The Permutit Co.

**229** **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering a recently developed amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free $CO_2$, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures The Bird-Archer Co

**230** **Chemical Feed Systems** — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps and a typical packaged installation. Milton Roy Co.

## ELECTRICAL

**231** **Electrical Diagram Guide**—The purpose and use of electrical diagrams supplied with switchgear equipment are explained in Bulletin GET 1293A. It was written to help those who install, operate or maintain switchgear equipment make the best use of the diagrams that come with such equipment. Discusses in detail one-line, elementary, connection and interconnection diagrams. It tells their scope and uses and illustrates symbols used and common variations and explains ASA device function numbers and conventions. General Electric Co.

**232** **Transformer Buyers Guide**—An excellent technical manual on instrument transformers is this 80-page catalog, GEA-4626B. Contains descriptions, photographs and index of ratings and construction for indoor and outdoor potential transformers, indoor and outdoor current transformers, outdoor metering outfits and portable potential and current transformers, according to cycles. Dimensions, prices and shipping weights are included with listing of each type, as is reference to manufacturer's bulletin dealing with that type of transformer. Index of types shows voltage and frequencies. Also included are tables showing mechanical and thermal limits of current transformers. Book has firm covers and ring binding for long-time reference use. General Electric Co.

**233** **Synchronous Generators**—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical con-


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struction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

**234** **Synchronous Motors** — High speed synchronous motors are described in this recently-issued 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

**235** **Mechanical Rectifiers** — Presenting mechanical rectifiers as a simple solution to the problem of low voltage power conversion, Bulletin 4809, 12 pp, covers their history and advantages, using charts and graphs as evidence of their inherent high efficiency. Also provides an illustrated explanation of rectifiers' operating principles. I-T-E Circuit Breaker Co.

## PUMPS, COMPRESSORS, ENGINES

**236** **Steam Engine Governor Data**—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the governor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

**237** **Condensers**—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

**238** **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

**239** **Air Compressor Lubrication Manual** —Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

**240** **Steam Pumps** — This is manufacturer's collection of bulletins covering all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

## INSTRUMENTS AND CONTROLS

**241** **Smoke Density Recorder** — Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

**242** **Boiler Water Level Control** — Bulletin 487 describes completely the


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With valve orifices up to 2" diam., Nicholson piston-operated steam traps offer unsurpassed drainage capacity. Universally specified for draining steam purifiers in power plants, where thousands are in use; discharge large volumes of water almost instantly. Increasingly installed wherever water and dirt in volume are a problem: superheated steam lines, headers, separators, heaters. Other features: won't leak even if cooked dry; rugged; working parts of stainless steel. Pressures, 2 to 650 lbs. The lowest price large-capacity trap manufactured.

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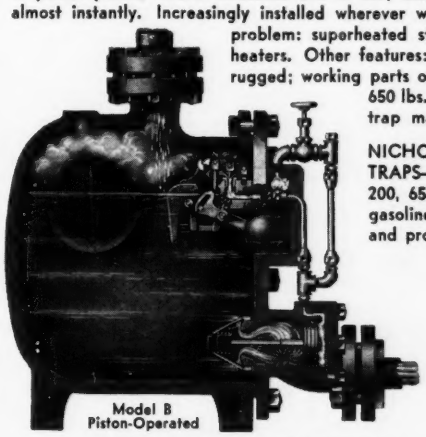

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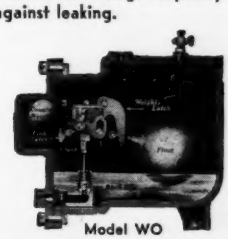

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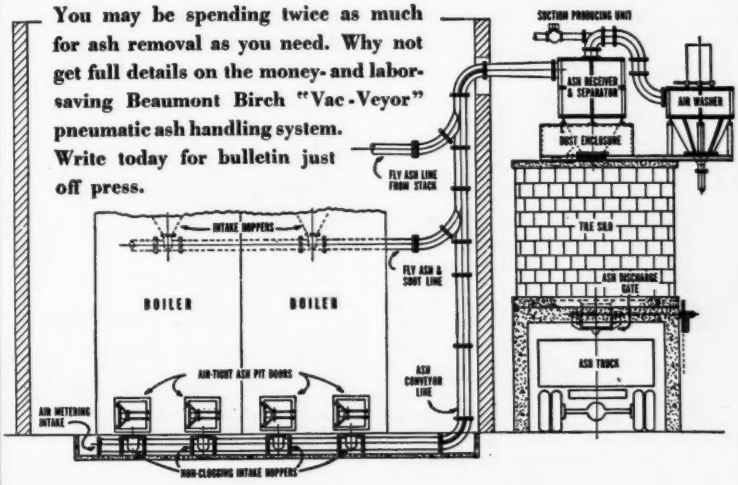


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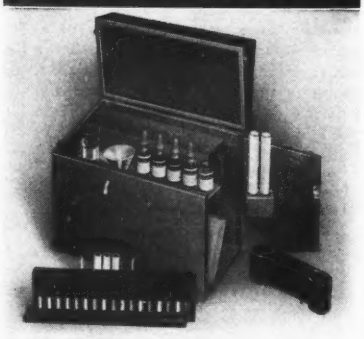

Model P contains either High *OR* Low Phosphate Comparator. Model W contains, in addition, 3 pH slides: pH 7.2—8.8; 8.6—10.2; 10—11.6 and all accessories.

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installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type FH integral furnace boiler is presented and other drawings and photographs show the accompanying equipment. Northern Equipment Company.

**243** **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

**244** **Instrument Handbook**—"Modern pH and Chlorine Control" is a 100-pp catalog containing a great deal of valuable information in addition to covering manufacturer's line of scientific instruments and accessories. It explains the meaning of pH control, the electrometric and colorimetric methods of determining pH, and gives values of common acids, bases and foods, as well as maximum capacities of buffer systems. It also discusses in detail the applications of pH and chlorine control in air conditioning, water treatment, boiler water and many other industrial applications, recommending instruments and solutions. Instruments are illustrated by photograph, their functions described and sizes and prices given. W. A. Taylor & Co.

**245** **Temperature Measuring Instruments** —For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-461 describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

**246** **Flow Meters** — The high accuracy, safety, flexibility, low maintenance, and other features emphasized for manufacturer's "Magna-Clutch" mechanical flow meters are explained in 8-pp Bulletin 49-915. Illustrated with photos and operational drawings, it also contains dimensional and meter piping sketches, as engineering specifications. The Hays Corp.

**247** **Metering Chlorine** — Bulletin 640-F2 describes an instrument designed to accurately meter chlorine gas and deliver a chlorine water solution to the point of application. Discusses the safety and other features of the instrument and explains its operation and maintenance. Illustrations include photos, a phantom drawing showing principle working parts, and a layout diagram. Builders-Providence, Inc.

**248** **Purity Indicator**—An instrument for measuring and indicating electrical conductance of steam and water is described and illustrated in 6-pp Bulletin 11-23-48 RCU. It discusses problems encountered with steam and condensate purity and cites examples of how controller and alarm assembly are utilized in detecting and signalling impurities caused by carryover and condenser leakage. Includes photos of typical test apparatus, also prices. E. F. Drew & Co., Inc.

## MATERIALS HANDLING

**249** **Dry Materials Conveyor** — Bulletin F-H-1 describes this company's revolutionary type of conveyor designed for the handling of fine, dry materials. The book, which contains 12 pages, presents excellent installation views of the conveyor, and also drawings which illustrate construction and method of operation. The bulletin points out that the conveyor has no moving parts and that it has no hazards to workmen, is silent in operation, requires no lubrication and can pass around obstacles. Fuller Company.

**250** **Screw Conveyor**—Two-pp Form A-84 describes a high-speed, direct-feed, bin-to-stoker screw conveyor that comes ready to set up. Illustrations show this conveyor in use and detail of its principal parts. Stresses economy of this conveyor in handling coal and includes specifications. Baughman Mfg. Co., Inc.


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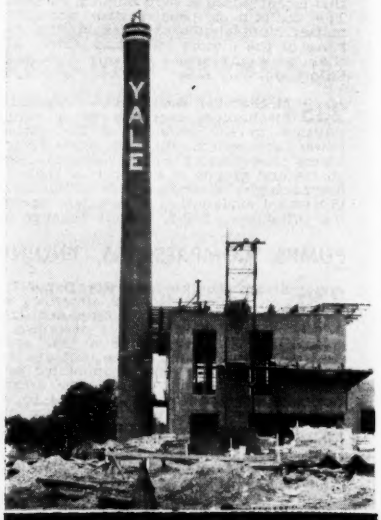


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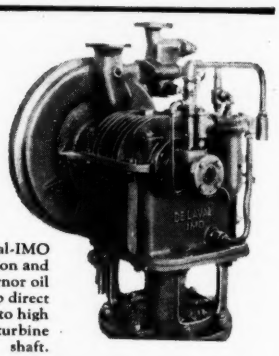

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## COAL HANDLING

**251** **Coal Scale Data Book**—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

**252** **Spreader Stoker Selection** — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

**253** **Coal Crushing, Sizing** — Bulletin 3007 describes the company's Bradford breaker a coal crusher, sizer and scavenger. The bulletin presents drawings of the breaker, tells how it works and then presents the complete story of its operation at the coal mine and coal cleaning plant at the By-Product Coke Plant and at the Power Station. The back section of the catalog presents engineering information on capacities, dimensions and dimensioned line drawings. Pennsylvania Crusher Co.

**254** **Coal Crusher**—In this 8-pp bulletin a rolling ring crusher is presented as a solution to the problem of uniform stoker coal. Describes the special features of this crusher, emphasizing its shredder designed to split coal rather than crush it. Gives speed, capacity, weight and dimensions of available models and illustrates principle of operation. Also contains photos of parts and several complete installations. American Pulverizer Co.

## TURBINES

**256** **Turbine Catalog Collection**—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

**257** **Velocity Stage Turbines** — Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described in detail. De Laval Steam Turbine Co.

## MISCELLANEOUS

**259** **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

**260** **Cooling Towers**—Double-flow cooling towers are featured in 20-pp Bulletin DF. It discusses the principle of double-flow cooling, the mechanical equipment utilized, construction features of a tower of this type, water distribution, coil shed, and safety factors. Recommends sizes for different applications and includes photos of many installations. The Marley Co., Inc.

**261** **Concrete Floors Q & A** — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corro-


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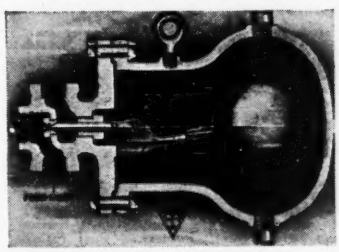

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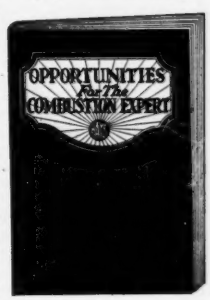


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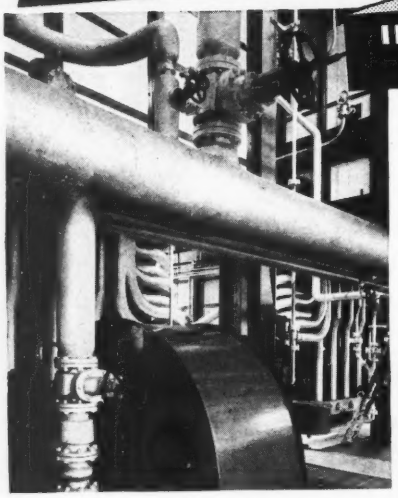

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sion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

**262** **Application Data Bulletin** — Titled "The Aroclors," chlorinated biphenyl and chlorinated poly-phenyls, this booklet describes the unique properties which enables this material to fulfill certain requirements. The Aroclors have won a place in the electrical insulating field and in such widely differing applications as non-flammable hydraulic media, high-temperature and high-pressure lubricants, heat-transfer and expansion media, sealing compounds, adhesives and protective coatings, including plastics, pigments, lacquers, paints and varnishes. This booklet contains 28 pages and presents the combined information gathered by the company from what it believes to be reliable and dependable sources. Monsanto Chemical Co.

**263** **Tube-Ice Machine** — Bulletin TI-3 describes manufacturer's automatic ice-making machine for producing either cylinder or crushed ice. Explains and illustrates machine's operation, discussing its small space requirement, quick freezing time, reduced power consumption and economy. Its application in the dairy and packing industries, breweries, chemical plants, institutions, and ice plants are described and pictured. Also discussed is the utilization of this machine in cold water refrigeration for air conditioning systems. Includes chapter on the handling and storage of ice. Henry Vogt Machine Co.

**264** **Purger Bulletin**—How air and other non-condensables get into refrigeration systems; the adverse effect of this on operating costs and efficiency and what manufacturer's forged steel purger does to prevent it are covered in 8-pp Bulletin 192. Also included are installation data with illustrations and diagrams, specifications and prices, helpful charts and tables. Armstrong Machine Works.

**265** **Intake Filters** — Manufacturer's line of intake filters of the "dry" type for combustion engines and compressors are described and illustrated in 8-pp Bulletin SIF. It covers standard, silencer and ground level installation models in medium and large capacities, small capacity filters and breather filters. Gives complete data on specifications, sizes, weights and capacities. Dollinger Corp.

**266** **Dust Collectors** — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 26 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

**267** **Transmission Belting** — Catalog M-9922, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings showing types of transmission drives. United States Rubber Co.

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## POWER PLANT CONSTRUCTION NEWS

*(Continued from page 100)*

structure on new Milesburg steam-electric generating station near Bellefonte. It will be equipped for an initial capacity of 44,000-kw, and is reported to cost about $8,000,000, with transmission lines, power substations and other operating facilities. Completion is scheduled late in 1950.

**Dixmont, Pa.**—General State Authority, 18th and Herr Sts., Harrisburg, Pa., has authorized plans for new steam power plant for central-heating service at State Hospital, Dixmont. Cost estimated about $600,000. A steam-distribution system will be installed to cost approximately $300,000 additional. J. E. Burke & Associates, Magee Bldg., Pittsburgh, Pa., are consulting engineers.

**Erie, Pa.**—Pennsylvania Electric Co., plans addition to Front St., steam-electric generating station, with installation of additional equipment for increased capacity. Cost reported about $12,500,000. Project will require about 24 months for completion and will be placed under way at early date.

**Somerset, Pa.**—General State Authority, 18th and Herr Sts., Harrisburg, Pa., plans new boiler plant for central-heating service at Somerset State Hospital, estimated to cost about $700,000, with boilers, stokers, pumps, and auxiliary equipment. Peter F. Loftus Corp., Oliver Bldg., Pittsburgh, Pa., is consulting engineer.

**Charleston, S. C.**—Virginia-Carolina Chemical Corp., 827 East Main St., Richmond, Va., agricultural and other chemicals, plans boiler plant at proposed new factory at Charleston for production of elemental phosphorous for commercial fertilizer manufacture. It will comprise several buildings. Entire project estimated to cost approximately $3,500,000. Construction is scheduled to begin soon.

**Columbia, S. C.**—South Carolina Electric & Gas Co., Columbia, has arranged an expansion and improvement program over a period of 60 months, dating from 1949 and concluding in 1953, estimated to cost about $34,000,000. Work will include extensions in generating stations, transmission lines, power substations and other facilities.

**Estelline, S. D.**—Town Council plans expansion in municipal oil engine-operated power station, with installation of new Diesel-electric unit and auxiliary equipment. Estimates of cost will be made at once.

**Chattanooga, Tenn.**—Tennessee Valley Authority, Knoxville, Tenn., has preliminary plans and surveys in progress for new steam-electric power plant at Hale's Bar Dam, about 22 mi. below Chattanooga. Station will be developed for large capacity, and will represent an ultimate investment of about $54,000,000. Project has been authorized by Congress.

**Bryan, Texas**—City Council plans extensions and improvements in municipal power plant, including installation of new turbine-generator unit and auxiliary equipment with rating of about 5000-kw. Cost reported close to $750,000. Freese, Nichols & Turner, National Standard Building, Houston, Texas, are consulting engineers.

**Houston, Texas**—Consolidated Western Steel Corp., 5700 Eastern Ave., Los Angeles, Calif., plans power plant in connection with new branch mill at Houston for production of welded steel pipe. Project will comprise several buildings and is reported to cost close to $4,000,000.

**Pasadena, Texas**—City Council is reported planning new municipal electric light and power plant, using Diesel engine-generator units and accessory equipment. Estimates of cost will be made soon.

**Beloit, Wis.**—Fairbanks, Morse & Co., Inc., 600 South Michigan Ave., Chicago, Ill., Diesel locomotives, pumps, farm equipment, etc., plans new steam-generating station at branch plant at Beloit. Estimates of cost are being made. Stone & Webster Engineering Corp., 33 South Clark St., Chicago, is consulting engineer.

**Green Bay, Wis.**—Wisconsin Public Service Co., Bellin Bldg., Green Bay, will begin work soon on substructure for proposed addition to local Pulliam-Bayside steam-electric generating station, to provide for installation of new turbine-generator and accessories, making sixth such unit at plant. Completion is scheduled late next year. No official estimate of cost announced.

**Richmond, Va.**—Richmond Public Utilities, City Hall, plans extensions and improvements in municipal steam-electric power plant and system, with installation of additional equipment. Cost reported close to $400,000.


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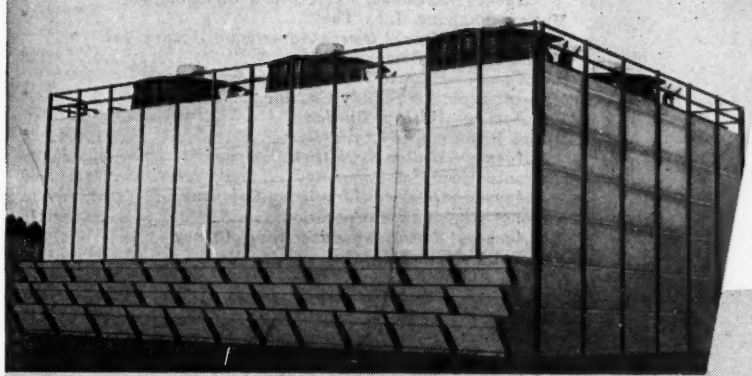

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American Blower Corp. ..... *
*Agency—Brooke, Smith, French & Dorrance, Inc.*
American Chimney Corp. ..... 118
American Engineering Co. ..... *
*Agency—John Falkner Arndt & Co., Inc.*
American Pulverizer Co. ..... *
*Agency—Eggers-Rankin Adv. Service*
Anthony Company, The ..... *
*Agency—Sanger-Funnell, Incorporated*
Armstrong Machine Works ..... 45
*Agency—Russell T. Gray, Inc.*
Atlas Valve Co. ..... *
*Agency—W. F. Schaphorst*
Babbitt Steam Specialty Co. ..... 124
*Agency—Paul L. Kuch Advertising*
Babcock & Wilcox Co., The ..... 24-25
*Agency—O. S. Tyson and Company, Inc.*
Bailey Meter Company ..... 26
*Agency—Fuller & Smith & Ross*
Baughman Manufacturing Co., Inc. ..... 112
*Agency—The Biddle Co.*
Beaumont Birch Company ..... 117
*Agency—The Harris D. McKinney Organization*
Belmont Packing & Rubber Co., The ..... 104
*Agency—McNevin-Wilson-Daldorf, Inc.*
Betz, W. H. & L. D. ..... 89
*Agency—The Harris D. McKinney Organization*
Bird-Archer Co., The ..... *
*Agency—Michel-Cather, Inc.*
Builders-Providence, Inc. ..... *
*Agency—Hammond-Goff Co.*
Cambridge Instrument Co., Inc. ..... *
*Agency—E. M. Freystadt Associates, Inc.*
Chapman Valve Mfg. Co., The ..... Inside Back Cover
*Agency—Sutherland-Abbott*
Cities Service Oil Co. ..... 33
*Agency—Ellington & Company, Inc.*
Cochrane Corporation ..... 103
*Agency—Willard G. Myers Advertising Agency*
Combustion Engineering-Superheater, Inc. ..... 16-17
*Agency—G. M. Basford Company*
Condenser Service & Engineering Co., Inc. ..... 116
Crane Co. ..... 43
*Agency—The Buchen Company*
Dart Mfg. Co., E. M. ..... 106
*Agency—Sutherland-Abbott*
Davis Engineering Corporation ..... *
*Agency—Thomas & Delehanty, Inc.*
Davis Regulator Co. ..... 110
*Agency—Armstrong Advertising Agency*
Dearborn Chemical Company ..... *
*Agency—The Fensholt Company*
DeLaval Separator Co., The ..... 28
*Agency—Donahue & Coe, Inc.*
DeLaval Steam Turbine Co. ..... 118
*Agency—Geo. H. Gibson Co.*
Detroit Stoker Company ..... *
*Agency—Witte & Burden*
Dollinger Corporation ..... *
*Agency—Casler, Hempstead & Hanford, Inc.*
Dowell Incorporated ..... *
*Agency—MacManus, John & Adams, Inc.*
Dravo Corporation ..... *
*Agency—Ketchum, MacLeod & Grove, Inc.*
Drew & Co., Inc., E. F. ..... 4
*Agency—The Aitken-Kynett Co.*
Edward Valves, Inc. ..... *
*Agency—Gebhardt & Brockson, Inc.*
Elliott Co. ..... 2-3
*Agency—Peterson & Kempner, Inc.*
Engineer Co., The ..... 31
*Agency—Michel-Cather, Inc.*
Erie City Iron Works ..... 91
*Agency—Davies and McKinney*
Ernst Water Column & Gage Co. ..... 109
Everlasting Valve Co. ..... 38
*Agency—Michel-Cather, Inc.*
Foster Engineering Company ..... *
*Agency—Sanger-Funnell, Incorporated*
Foster Wheeler Corp. ..... 12-13
*Agency—Albert Frank-Guen'her Law, Inc.*
Fuller Company ..... *
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General Electric Company ..... *
*Agency—G. M. Basford Company*
Gifford-Wood Co. ..... *
*Agency—O. S. Tyson and Company, Inc.*
Golden-Anderson Valve Specialty Co. ..... 124
*Agency—Walker & Downing*
Goodall Rubber Co., Inc. ..... 113
*Agency—George C. Taylor*
Graver Water Conditioning Co. ..... 107
*Agency—Michel-Cather, Inc.*
Grinnell Co., Inc. ..... *
*Agency—Horton-Noyes Co.*
Griscom-Russell Co., The ..... 40
*Agency—Michel-Cather, Inc.*
Hagan Corporation ..... 30
*Agency—Ketchum, MacLeod & Grove, Inc.*
Hall Laboratories, Inc. ..... 18
*Agency—Ketchum, MacLeod & Grove, Inc.*
Hays Corporation, The ..... *
*Agency—Gebhardt & Brockson, Inc.*
Hays School of Combustion ..... 119
*Agency—Kreicker & Meloan, Inc.*
International Nickel Co., Inc., The ..... 32
*Agency—Marschalk & Pratt Co.*
I-T-E Circuit Breaker Company ..... *
*Agency—Richard A. Foley Advertising Agency, Inc.*
Jefferson Union Co. ..... 116
Johns-Manville ..... *
*Agency—J. Walter Thompson Company*
Kellogg Co., The M. W. ..... 93
*Agency—Gordon Baird Associates, Inc.*
Leeds & Northrup Company ..... *
*Agency—Geare-Marston, Inc.*
Link-Belt Co. ..... 101
*Agency—Don Proctor Advertising*
Lovejoy Flexible Coupling Co. ..... 124
*Agency—Symonds, MacKenzie & Company, Inc.*
Marley Company, Inc., The ..... *
*Agency—Merritt Owens Advertising Agency, Inc.*
Maxim Silencer Company, The ..... 123
*Agency—Edward W. Robotham & Company*
Midwest Piping & Supply Co., Inc. ..... *
*Agency—Witte & Burden*
Milton Roy Company ..... *
*Agency—Walter S. Chittick Company*
Monsanto Chemical Company ..... 49
*Agency—Gardner Advertising Company*
National Aluminate Corporation ..... 34, 116
*Agency—Armstrong Advertising Agency*
National Valve & Mfg. Co. ..... *
Niagara Blower Co. ..... *
*Agency—The Moss-Chase Company*
Nicholson & Co., W. H. ..... 117
*Agency—Wilbur A. Myers*
Northern Equipment Company ..... 51
*Agency—Davies and McKinney*
Pacific Pumps, Inc. ..... 100
*Agency—The McCarty Company*
Pennsylvania Crusher Co. ..... *
*Agency—McLain-Dorville, Inc.*
Permutit Co., The ..... *
*Agency—Newell-Emmett Co.*
Pipe & Tubular Products, Inc. ..... 119
Prat-Daniel Corp. ..... *
*Agency—The Harry P. Bridge Company*
Pritchard & Co., J. F. ..... 121
*Agency—Carter Advertising Agency, Inc.*
% Proportioneers, Inc. % ..... 6
*Agency—Hammond-Goff Co.*

Quaker Rubber Corp. ..... *
*Agency—A. E. Aldridge Associates*
Reliance Gauge Column Co., The ..... *
*Agency—Carr Liggett Agency, Inc.*
Republic Flow Meters Co. ..... 14-15
*Agency—Glenn, Jordan, Stoetzel, Inc.*
Richardson Scale Co. ..... 111
*Agency—O. S. Tyson and Company, Inc.*
Ric-Wil Co., The ..... 41
*Agency—Meermans, Inc.*
Rockwell Mfg. Co. ..... *
*Agency—Gebhardt & Brockson, Inc.*
Ross Heater & Mfg Co., Inc. ..... *
*Agency—Harold Warner Company*
Roto Div. of Elliott Co. ..... 102
*Agency—Jos. S. Vogel & Co.*
Sarco Company, Inc. ..... 19
*Agency—W. L. Towne Advertising*
Simplex Valve & Meter Co., The ..... *
*Agency—Newell-Emmett Co.*
Sinclair Refining Co. ..... 20-21
*Agency—Morey, Humm & Johnstone, Inc.*
Southern Coal Company, Inc. ..... *
*Agency—The Potts-Turnbull Co.*
Springfield Boiler Co. ..... 39
*Agency—Armstrong Advertising Agency*
Standard Oil Co. (Indiana) ..... 27
*Agency—McCann-Erickson, Inc.*
Stets Company ..... 119
Stone & Webster Engrg. Corp. ..... *
*Agency—Harold Cabot & Co., Inc.*
Sun Oil Company ..... 47
*Agency—Gray & Rogers*
Taylor and Co., W. A. ..... 118
*Agency—Emery Advertising Corporation*
Terry Steam Turbine Co., The ..... 99
*Agency—Michel-Cather, Inc.*
Texas Co., The ..... Back Cover
*Agency—Buchanan & Company, Inc.*
Thermix Corp., The ..... *
*Agency—The Harry P. Bridge Co.*
Tide Water Associated Oil Co. ..... 37
*Agency—G. M. Basford Company*
Todd Shipyards Corporation (Combustion Equipment Div.) ..... *
*Agency—Wendell P. Colton Co.*
Treasury Department ..... 115
Troy Engine & Machine Co. ..... 108
*Agency—Sanger-Funnell, Incorporated*
Tube Turns, Inc. ..... *
*Agency—Roche, Williams & Cleary, Inc.*
United States Rubber Company ..... *
*Agency—Fletcher D. Richards, Inc.*
United States Steel Corp. ..... *
*Agency—Batten, Barton, Durstine & Osborne, Inc.*
Universal Atlas Cement Co. (Lumnite Division) ..... *
*Agency—Batten, Barton, Durstine & Osborne, Inc.*
Vogt Machine Co., Henry ..... 95
*Agency—Farson & Huff*
Warren Steam Pump Co., Inc. ..... 105
*Agency—The Davis Press, Inc.*
Western Precipitation Corp. ..... *
*Agency—Dozier-Graham-Eastman Advertising*
Wheeler Mfg. Co., C. H. ..... 22-23
*Agency—Eugene A. Holland*
Whitlock Mfg. Co., The ..... *
*Agency—Hammond-Goff Co.*
Wickes Boiler Co., The ..... 97
*Agency—Price, Hedrick & Tanner, Inc.*
Wiley & Sons, Inc., John ..... *
*Agency—The Waterson Company*
Wing Mfg. Co., L. J. ..... *
*Agency—Willard G. Myers Advertising Agency*
Worthington Pump & Machinery Corp. ..... 29
*Agency—James Thomas Chirurg Company*
Wright Chemical Corporation ..... 120
*Agency—Schnell & Associates, Inc.*
Yarnall-Waring Company ..... 10-11, 52
*Agency—Walter S. Chittick Company*


Firms whose advertising is not in this issue but is appearing in other issues are marked with an *


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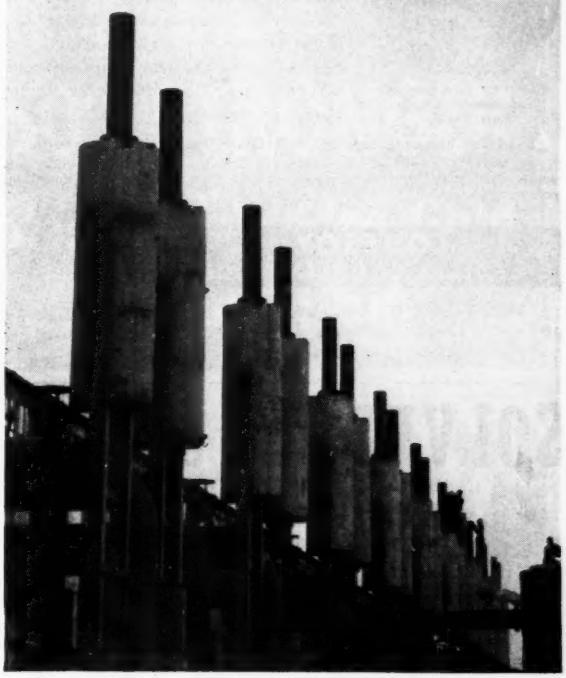

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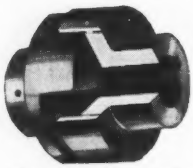

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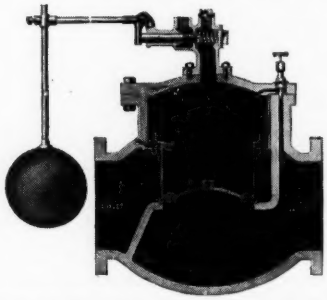

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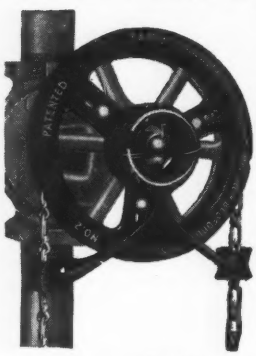

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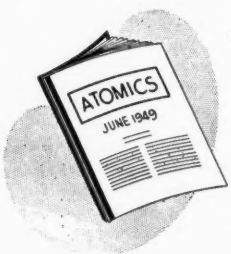


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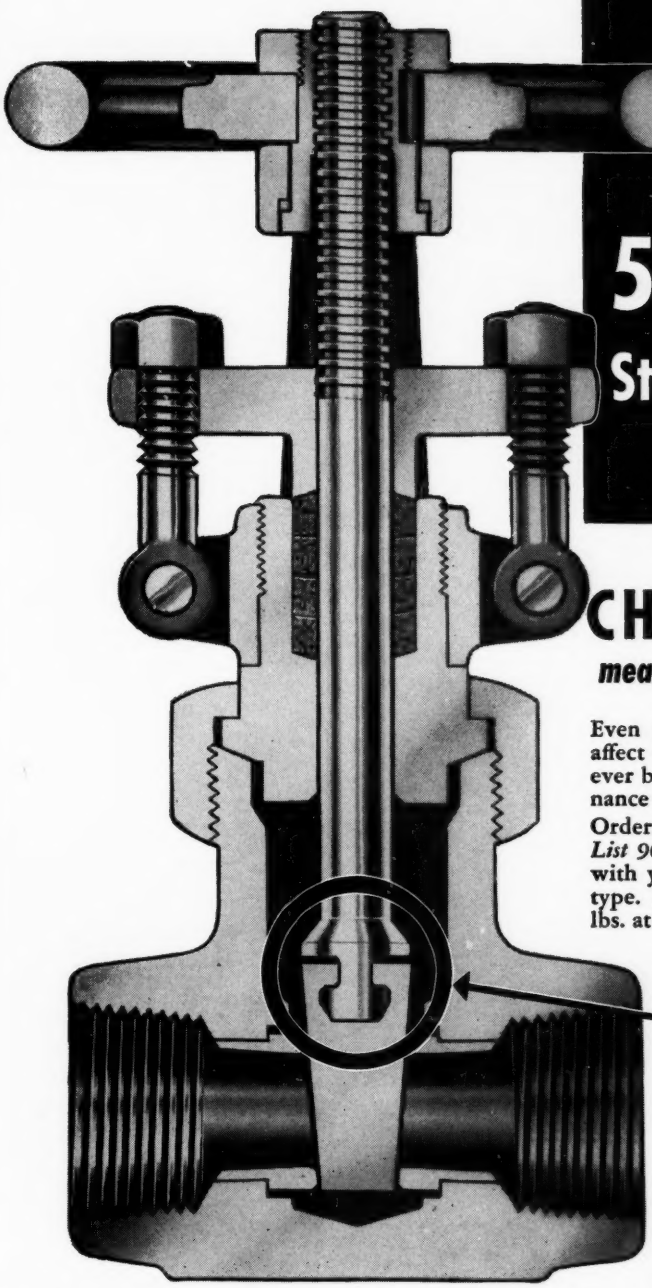

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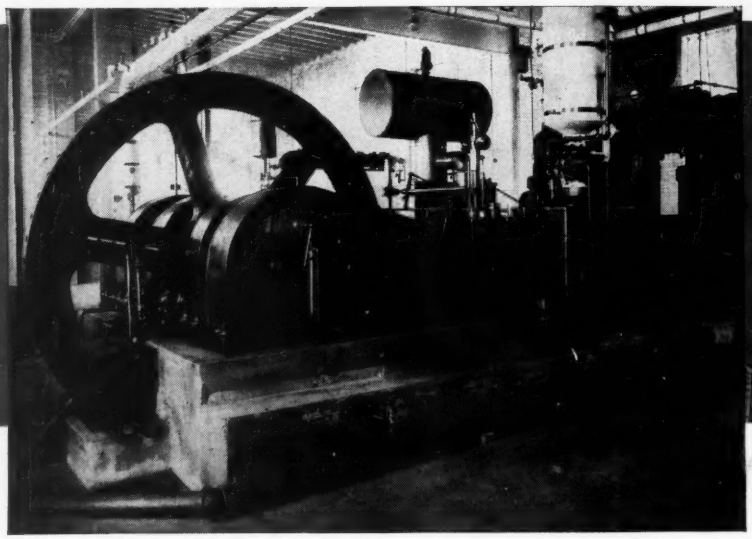

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INDEX TO VOLUME LIII, 1949

# POWER GENERATION

## SUBJECT INDEX

**A star denotes an illustrated article; q, a question answered; PE, an article of the Practical Engineer Section; EP, an item in the Engineers' Preview. An index to the names of authors follows the Subject Index.**


## A

Abrasive, Flexible ..... Aug *46
Accumulator on Lines to Steam Presses? Should He Use ..... Dec q 80
Additives ..... PE Feb 85
..... Apr 53
..... June 53
..... Sept 53
Air Compression and Humidity, Simplify Your Calculations for.. May *70
Air-cooled Engines, Heavy Duty ..... Jan EP 8
Air For G-M Factory, Turbine-Driven Compressors Supply..... Aug *54
Air Impact Tool ..... Oct *50
Air Pressure Influence Pneumatic Control Systems, How Tankage and Operating ..... Feb *62
Air Percentages More Accurately, Calculate Your Excess..... July *58
Air Pump, How We Fixed the Turning Liners that Stopped.. PE Apr 85
Air System Leakage? How Measure Compressed ..... PE Feb q 91
..... PE Apr 86
..... PE May 82
Air Was Wet, Why the Compressed ..... Nov *92
Aircraft Propulsion, Atomic Power and Its Implication for..... Sept 78
Aircraft Warning Lights on Stacks, Control of ..... July 84
Alaska's Power Potential Being Overlooked? Is ..... Aug *88
Alford's New 17-Acre Warehouse in Dallas, Refrigeration and Power for ..... Sept *90
Align a Four-Bearing Turbine Generator Set, How to..... PE Feb *84
Alignment, Pipe ..... Aug *112
Alternating-Current Machinery, Shaft Currents in ..... Nov *102
Aluminum Pistol? ..... Nov EP 7
American Industry Can Lead the World in Human Relations..... Feb *53
Ammeter and Voltmeter..... June *50
Ammeter, Pocket Type ..... Sept *50
Ammeter, Small ..... Dec *46
Ammonia Refrigeration Plant? Who Knows about Incentive Bonus Systems for ..... PE Jan 91
Analyze Pipe Stress, Let the Flexibility Prism Help You ..... Dec *58
Analyzer ..... May *48
Announcing An Expanded Atomics Service ..... June 63
Annunciator ..... Apr 42
..... June *44
..... July *46
Answer Yes or No!—Are Piston Rods ever Bowed ..... PE..May q 82
..... July 76
Antennae Give Automatic Control to Coal Hopper Gate..... June *84
Anthracite Coal Burning..... June EP 8
Applications of Rotating Regulators, Industrial ..... Apr *66
Arc-Welded a Steel Expansion Joint, How We ..... Aug *57
Armature Tester ..... May *46
Armature Winding Diagram, A New ..... Oct *66
Arrester and Cutout ..... Dec *42
ASME Boiler Code ..... Nov EP 7
ASME Holds 1949 Semi-Annual Meeting at San Francisco..... July 85
ASME Meeting; Engineering Opportunities, Reheat, Gas Turbines, Controls — Featured at 69th Annual ..... Jan *74
Atomic Energy ..... Jan 68
Atomic Energy Development, Ten Years of ..... Mar *86
Atomic Power and Economic Development ..... May *72
Atomic Power and Fuel Supply..... Nov 75
Atomic Power and Its Implication for Aircraft Propulsion ..... Sept 78
Atomics Service, Announcing An Expanded ..... June 63
Atomizing Valve ..... Dec 48
Australia Plans New Hydro-Irrigation Scheme ..... July 79
Authority in TVA Land..... May BR 130
Automatic Air Valves ..... May 48
Automatic Control, Cuban Power Plant Features ..... July *96
Automatic Control to Coal Hopper Gate, Antennae Give..... June *84
Automatic Cost of Living Wage Adjustments ..... Apr EP 8
Automatic Fire Protection for Pulverized Coal Filters..... May *84
Automatic System ..... Nov *48
Automatic Temperature Monitoring at Sewaren, Centralized..... Oct *70

## B

Backwashing Ion Exchangers, Tips for Operators on..... June *60
Balancing Rotors Without Special Equipment ..... Nov *94
Bankside Power Station, New..... Jan *96
Basic Electrical Engineering.... June BR 128
Basic Marketing Chart of the United States ..... Aug EP 8
Basic Power Plant Figuring..... PE Feb *82
..... PE Mar *94
..... PE Apr 82
..... PE May *78
..... June 59
..... July 60
..... Aug 72
..... Sept 74
..... Oct 86
..... Nov *82
..... Dec 74
Battery Chargers ..... Dec *42
Battery For A Power Plant? Can We Use A Cadmium Storage..... July q 76
..... Sept 80
..... Nov 78
Beauty Vs Age ..... July 60
Belt Conveyor System 130 miles Long ..... Mar EP 7
Berg, J. D. ..... Sept. 100
B. F. Pumps for Safety Valve Blow? Why Design ..... PE Jan 91
Bi-lingual Elevator ..... Sept EP 8
Bitter on Sunday, Why the Maintenance Man Is ..... Oct 96
Blade, Solid Scroll-Saw..... Jan EP 8
Bleeder, Capillary ..... Dec 46
Blowdown, Continuous ..... Sept *46
Blower, Forced Draft ..... Oct. *44
Blueprint Protection ..... Dec *98
Blum, Sr., Richard J. ..... Jan 112
Boiler Design by Eliminating Enshrouded Mystery, Simplifying.... Feb *74
Boiler Design—I, Solvent Cleaning and ..... Jan *69
..... Feb *59
Boiler Feed Pump Operation in 2-Unit Power Plants ..... Nov *72
Boiler Feedwater Control, Lecture on ..... Jan EP 7
Boiler Plant at Jackson, Goodyear Builds New ..... Apr *90
Boiler Sludge With a Silica Equilibrium, Reducing ..... Mar *76
Boiler Stoker Units ..... Nov *48
Boiler Tube Failures by Using this Scale Thickness Indicator, Forestall ..... June *58
Boilers to Texas City, Moving Six Marine ..... Feb *73
Boilers, Two-Drum ..... Dec *50
Boilers, Use of Chloride Salts for Freezeproofing of Coal for Utility ..... May 57
Boilers, Water Tube ..... May *46
Boilers? What Causes Burner Trouble and High Draft in These ..... Nov q 78
Bolt Machine, Pipe and ..... June *48
Bolt Solid with a Sleeve, Make Your Toggle ..... Aug *94
Bonus Systems for Ammonia Refrigeration Plant? Who Knows about Incentive ..... PE Jan 91
Bouquets and Brickbats ..... July 53
Bowed? Answer Yes or No!—Are Piston Rods Ever ..... PE May q 82
..... July 76
Braking Airliners in Flight..... Mar EP 8
Brickbats, Bouquets and..... July 53
Britain's Industrial Power..... Oct *84
Brookhaven Atomic Pile, First Graphite Put Into Place at..... Jan 80
Brush Holders, Radial ..... Feb *48
Bubble Blowers, Ultra-Fancy.... Jan EP 7
Buffer Solutions ..... Nov 48
Burn Heavy Fuel Oil, Tacubaya Diesels ..... Sept *59
Burn Waste Fuels? What Does It Cost You to ..... Nov 90
Burner, Automatic ..... Mar *56
Burner, Boiler ..... July *44
Burner Trouble and High Draft in These Boilers? What Causes.... Nov q 78
Burner Units, Dow Installs First Industrial Cyclone ..... Mar *78
Businesses, Small ..... Feb EP 8

## C

Cabinets, Steel Drawer..... May 50
Cable Stripper ..... Dec *50
Cables to Meet Short-Circuit Requirements, Selecting Power..... Feb *64
Cadmium Storage Battery For A Power Plant? Can We Use A.. PE July q 76
..... PE Sept. 80
..... PE Nov 78
Calculate Condenser Spring Supports? How ..... PE Jan *90
..... PE Mar 99
Calculate Your Excess Air Percentages More Accurately..... July *58
Calculations for Air Compression and Humidity, Simplify Your... May *70
Calculator for Volumes of Oil and Other Petroleum Products.... PE May *77
Calculator, Tank ..... Sept *50
California People, More Power for More ..... Sept *61
Can They Use Molasses as a Fuel?.. Dec q 81
Capacitor ..... Aug *42
Capacitor, Secondary ..... June 50
Capillary Bleeder ..... Dec 46
Carnegie Tech, Homopolar Generator to Excite Synchro-cyclotron at ..... Nov *70
Carroll, Bechtel and Langtry now Under Their Own Names..... Sept 67
Carryover Prevention ..... June EP 8
Case of the Creeping Lightning, The ..... PE Apr *82
Catalyst, Combustion ..... Nov 48
Cement, Finishing ..... Oct *48
Central Heating Pays—Why Don't We have More of it? ..... Dec *88
Centralized Automatic Temperature Monitoring at Sewaren..... Oct *70
Centrifugal Pumps ..... Aug *42

Ceramic Bodies ....Nov EP 7
Challenge of the American Know-How ....Nov BR 110
Changer, Load Tap ....Dec *48
Changer, Speed ....May *46
Characteristics of Unusual Waste Fuels ....June 59
Chargers, Battery ....Dec *42
Chart Simplifies Fuel Purchasing..Dec *63
Check, An Inverted ....Feb EP 8
....Apr EP 7
Check, Water Hammer ....May *44
Chemical Feeder ....Dec *48
Chimney Insulated with Mineral Wool, Large ....PE Aug 85
Chloride Salts for Freezeproofing of Coal for Utility Boilers, Use of ....May 57
Chlorine Gas Feeder ....June 48
Circulators, Condensate ....Aug *44
Circuit Breakers ....Jan *48
....June *42
Circuit Grounded Through a Fuse? Why is This ....Aug q 78
....Oct 80
....Nov 79
....Dec 81
Cleaner, Inexpensive Air ....PE Feb 87
Cleaning and Boiler Design—I, Solvent ....Jan *69
....Feb *59
Cleaning Large Hydraulic Turbine Runners ....Nov *67
Cloudy Oil ....PE Apr 84
Coal-burning, Steam-turbine, Electric Drive Locomotive....Oct EP 7
Coal by Tractor Equipment, Handling ....Mar *70
Coal Explosion, Pulverized....Nov *86
Coal Freezeproofing and Corrosion ....May 57
Coal, Frozen ....Sept 53
Coal Hopper Gate, Antennae Give Automatic Control to ....June *84
Coal Still Heads the Energy Parade ....Jan *57
Coal Storage Now? Need Reserve....Feb *70
Coating Prevents Slag on Boiler Heating Surfaces, Protective....July 74
Coating, Protective ....Oct 48
Cocks, Service ....July *42
Coding of Thermocouple Wire and Extension Wire, Tentative Recommended Practices, RP1.1 ....May BR 124
Combustion Catalyst ....Nov 48
Combustion Engineering-Superheater Helps Export Technical "Know-How" ....Oct 58
Combustion Safeguard ....July *46
Common Sense Isn't As Common As It Should Be ....Dec 53
Compare Simplex and Duplex Pump Efficiencies? How Can He ....PE May q 82
....July 77
....Aug 78
Comparison of Conventional and Sludge-Blanket Softeners at a Firestone Plant ....Sept *70
Competition Between the Fuels..Oct EP 7
Completes Its Topping Program, Waterside ....May *62
Compressed Air Was Wet, Why the ....Nov *92
Compressible Lubricant ....Nov *50
Compressors, Hydrocol Process Requires 80,000 hp in....Aug *61
Compressors, Portable ....Oct *50
Compressors Supply Air For G-M Factory, Turbine-Driven ....Aug *54
Concrete Drill, Rotary ....Feb *44
Condensate, Increasing Power Plant Wash-Water By Using Wasted ....Aug *60
Connectors, Solderless ....Mar 56
Conquered—He Went Right Back to Sea! He Came Ashore—He Saw—He Was ....PE Feb 90
Contactor, Air Break ....Oct 46
Continue These Practices? Why....Sept *64
Control Center ....Mar *60
Control Device ....Dec *44
Control, Feedwater ....Apr *46
Control of Aircraft Warning Lights on Stacks ....July 84
Control? How Design Overflow Pipe for Close Level ....PE Feb q 91
....PE Apr *87
Control, How We Use Industrial Process Instruments in Power Plant ....Aug *81
Control, High Voltage Motor....Aug *58
Control, Micro Switch ....Sept *48
Control to Fit, We Tailored Our Smoke ....July *56
Control, Rolling ....Oct *42
Control System for Southern California Edison, Microwave Relay..Dec 87
Controller, Pyrometer ....Nov 44
Conventional and Sludge-Blanket Softeners at a Firestone Plant, Comparison of ....Sept *70
Conversion Tables, Temperature ....PE Jan *92
Conveyor for Cahokia, New Stocking-Out ....Jan 94
Conveyors and Related Equipment ....Aug BR 127
Cooler, After ....Mar *54
Cooler, Drinking Water ....Sept *42
Cooling of Large Electrical Machines, Vaporization ....May *67
....Sept *82
Cooling System for Internal Combustion Engines, Recirculation ....PE Apr *81
Cooling Tower ....June *42
Cooling Tower, Water ....May *42
Corrosion, Coal Freezeproofing and ....May 57
Corrosion, Dow Chemicals Takes Own Medicine—No ....May 59
Corrosion of Pressure Vessels....July EP 8
Corrosion to Coal Freeproofing Chemicals, This Plant Traces....May *58
Counter, Photoelectric ....Sept 48
Coupling, Electrical ....July *48
Coupling, Glass-Pipe ....Oct *42
Coupling Selector ....Mar *56
Creeping Lightning, The Case of The ....PE Apr *82
Crerar Library, The John....Mar EP 7
Criticism of Engineering Education, A Laborer's ....Nov 76
Cuban Power Plant Features Auto Control ....July *96
Cunningham, Nominated to Head ASME; James D. ....Aug *80
Cup-Gage, Combination ....Dec 46
Current Limiter ....May 48
Currents in Alternating-Current Machinery, Shaft ....Nov *102
Cut Good Threads By Hand, How To ....PE Mar *90
Cut-Off, Low Water ....Nov *42
Cutmeter, Tachometer and ....Dec *44
Cutout, Arrester and ....Dec *42
Cutout, Distribution ....Mar *56
Cutout, Heavy Duty ....Apr 44
Cuts I. D. Fan Outage from 1 Week to 16 hr at Delray; New Maintenance Method ....Sept *62
Cutters ....Feb *44
Cyclone Burner Units, Dow Installs First Industrial ....Mar *78


# D


Daly, John L. ....Sept 100
Damage? How Much Can Applied Motor Voltage Be Varied Without ....PE Apr q 86
....June 75
Dampeners, Vibration ....June *44
Day? Where Would You Put 300 Tons of Fly Ash Every ....Dec *85
D-C Welders ....Dec 46
Decatur, Staley Expands Power Plant at ....May *54
DeLaval Engineering Handbook..Oct BR 132
Delta Systems; Locating Grounds on 480-v, 3-phase ....Sept *60
De-Scaler, Boiler ....July 44
Descaling, Engine ....Feb 48
Design by Eliminating Enshrouded Mystery, Simplifying Boiler ....Feb *74
Design Overflow Pipe for Close Level Control? How ....PE Feb q 91
....PE Apr. *87
Designed for Economy and Dependability, O. H. Hutchings Station Now Serves Dayton—....Feb *54
Designing Safety into Power Plants and Their Equipment....Apr *54
Details of New F & E Spreader Stoker ....Jan *94
Detector, Metal ....Dec *48
Detector, Smoke ....May *44
Detection for Health Protection, Radiation ....Oct 77
Determines Maximum Boiler Feed Pump Discharge Pressure? What..July *80
Development of 1948 in Power Stations and Equipment....Jan *58
Device to Locate Faulty Joints in Overhead Lines ....PE Feb 87
Diagram, A New Armature Winding ....Oct *66
Diesel, Dual Fuel ....Feb *46
Diesel Engineering Handbook..May BR 122
Diesel Engines ....Sept BR 128
"Diesel" Gumout ....Apr 42
Diesel, Large V-type ....Aug *44
....Nov *42
Diesel Plant, 5 kw ....July *42
Diesels Burn Heavy Fuel Oil, Tacubaya ....Sept *59
Diesels Quadruple Petoskey Hydro, Three 1440-hp....June *57
Differential Fluid Meters....May BR 130
Discharge Pressure? What Determines Maximum Boiler Feed Pump ....July *80
Diseases of the Skin in the Electrical Industry Occupation..PE Mar 92
Does It Pay to Take an Interest in One's Work? ....PE Jan 87
Don't Forget the Lithium-Hydrogen Reaction ....Apr *74
Don't Worry About New Thread Standards ....Nov *66
Don't Worry About the Uranium Supply ....Jan *78
Doubtful Water Level ....PE May 80
Douglas Project, The ....Oct BR 114
Dow Chemical Takes Own Medicine—No Corrosion ....May 59
Dow Install First Industrial Cyclone Burner Units ....Mar *78
Draft in These Boilers? What Causes Burner Trouble and High ....Nov q 78
Drafting Machine ....Oct *42
Drill, Electric ....Jan *50
....Mar 62
Drive, Hydraulic Sheave ....Sept *48
Drive, Power Supply Affects Choice of Mine Hoist ....Dec *64
Drive, Speed Control ....Apr 50
Drive, World's Most Powerful Motor ....Feb 60
Drop Load and Lose Vacuum? What Makes Turbine No. 2 ....Aug q 78
....Oct 82
....Dec 82
Dual-Fuel Engine Can Do, What the ....Aug *102
Duct, Feed-in ....June *44
Durimet 20 ....Oct 44
Dutch Pumping Stations, Old ....PE Jan *82
Dynamic Equipment Policy....Oct BR 132


# E


Economic Development, Atomic Power and ....May *72
Economizer Re-Design ....Oct 53
Economizer Tube Plugs, Extractor for ....Sept *65
Education, A Laborer's Criticism of Engineering ....Nov 76
Efficient Use of Steam, The....Nov BR 112
Electric Plant ....Apr *44
....Aug *44
Electric Power Development in the U. S. in 1948....Jan *54
Electric Power Use ....July EP 8
Electric Shock—Can Be Either Injury or Treatment ....Dec *96
Electrical Art? What's New in the..Mar *82
Electrical Connections, Speed Nut Fastener Simplifies ....Jan *86
Electrical Engineering Advances....Jan *64
Electrical Equipment Industry Getting Back to Normal But on Higher Level ....Aug 92
Electrical Hazards With Metallic Tapes, Rules ....Nov 77
Electrical Industry, Occupational Diseases of the Skin in the....PE Mar 92
Electrical Machines, Vaporization Cooling of Large ....May *67
....Sept *82
Electrically-heated Rubber ....June EP 7
Electrode Assemblies ....Dec *44
Electromagnet, Deep Burden....Jan *42
Electronic Cell ....Nov *46
Electronic Regulators, Maintenance of ....Mar *73
Electronic Starter ....Dec 50
Elements of Diesel Engineering ....Nov BR 112
Elements of Applied Hydrology ....June BR 128
Elements of Mechanical Vibration ....July BR 127
Elevator Bucket ....Apr 48
11th Midwest Power Conference....June 61
Eliminate Static From Shafting, How to ....Sept 88
Eliminates Radio Interference With Inert Arc Welding, New System ....PE Feb *87
Employee Counseling ....June EP 8
Enclosures Behind Waterwalls, Refractory ....Dec *86
Engine Can Do, What the Dual-Fuel ....Aug *102
Engine-pressure-indicating System ....Sept EP 7
Engine? What is Best Length for Adjustable Piston Valves on Uniflow ....PE Jan q 90
Engineering Advances, Electrical....Jan *64
Engineering Data Manual for Water Cooling Problems....Sept BR 128
Engineering Laboratory at Pittsfield, New High-Voltage....Sept *66
Engineering Opportunities, Reheat, Gas Turbines, Controls—Featured at 69th Annual ASME Meeting ....Jan *74
Engineering Specialists, Demand for ....May EP 7
Engineers, The Trouble With....Oct 94
Engines, Recirculation Cooling System for Internal Combustion ....PE Apr *81
Equalizing Pipes, Finding Size of Filling and ....PE Mar *99
Equipment, Humidity ....Dec *46
Equipment, Metallizing Repairs on Hydroelectric ....Dec *92
Estep, Thomas G. ....Oct 116
Excess Air Percentages More Accurately, Calculate Your....July *58
Exchanger, Heat ....Dec *50
Exchange Resins Work, How Ion....Feb *94
Exchangers, Heat ....Jan *46

Exchangers, Tips for Operators on Backwashing Ion ..... June *60
Exhaust Steam Saves 800 Tons of Coal Annually, Use of ..... July *79
Expander, Finger U ..... Aug *50
Expander, Tube ..... May *42
Expansion Conduit ..... Mar 58
Expansion Joint ..... Sept *46
Expansion Joint, How We Arc-Welded a Steel ..... Aug *57
Expansion Joints, Rubber ..... Feb *50
Explosion, Pulverized Coal ..... Nov *86
Extinguisher, Powder ..... Mar 58
Extractor for Economizer Tube Plugs ..... Sept. *65


# F


Factor and What to Do About It, Telephone Influence ..... Dec *68
Factor, The Human ..... PE Feb 89
Facts with a Punch ..... May EP 8
Faith of Jingles Joe, The ..... Aug *96
False End Points, New Versenate Test for Total Water Hardness Eliminates ..... Dec *79
Family Space Requirements ..... Mar EP 8
Fan and Blower Industry; Standards, Definitions and Terms in Use by the ..... Mar EP 7
Fan Guarantees Worth? What Are ..... Oct *62
Fan Speed Indicator ..... July *84
Fastener Development ..... Mar 58
Fastener Has Many Uses, New Type ..... PE Feb *88
Fastens Steel to Steel, Powder-Actuated Handtool ..... PE Feb *86
Federal Prose ..... Sept EP 7
Feeder, Chemical ..... Dec *48
Feedwater Control ..... Apr *46
Feedwater, How to Prevent Ion Leakage in Exchange Treatment of ..... May *86
Fifty Years Old—Still Going Strong ..... PE May *81
Figuring—I, Basic Power Plant ..... PE Feb. *82
..... PE Mar *94
..... PE Apr 82
..... PE May *78
..... June 59
..... July 60
..... Aug 72
..... Sept *74
..... Oct *86
..... Nov *53
..... Nov *82
..... Dec *74
File of Key Engineering Personnel ..... Aug EP 8
Filling and Equalizing Pipes, Finding Size of ..... PE Mar *99
Film, Plastic Insulating ..... Sept 50
Filter, Condensing ..... Oct *48
Filter, Portable ..... Jan *44
Filters as Fuel ..... Sept 67
Filters, Automatic Fire Protection for Pulverized Coal ..... May *84
Filters, For ..... Feb *44
Finding Size of Filling and Equalizing Pipes ..... PE Mar *99
Fire Control ..... Jan *50
Fire Protection for Pulverized Coal Filters, Automatic ..... May *84
First Graphite Put Into Place at Brookhaven Atomic Pile ..... Jan 80
First Iron Works in U. S. ..... Aug EP 8
Fittings, Tube ..... Sept *44
Flame Failure Safeguard ..... Feb *44
Flame-Resisting Oil Tank, New ..... July EP 8
Flame-retardant Chemical ..... Nov EP 7
Flame Spraying of Polythene on Metal Surfaces ..... Aug EP 8
Flashlight in Working Order, Keep Your ..... PE Mar *96
Flashover Indicator ..... Oct *46
Floodlights, Heavy Duty ..... Dec *48
Flow Meter ..... Nov *42
Flux, Soldering ..... Jan 50
Fly Ash Every Day? Where Would You Put 300 Tons of ..... Dec *85
Fly Ash, Reburning Stoker ..... June *54
Forced Draft Blower ..... Oct *44
Forestall Boiler Tube Failure by Using this Scale Thickness Indicator ..... June *58
Foundations of Nuclear Physics ..... Dec BR 108
Four-Bearing Turbine Generator Set, How to Align a ..... PE Feb *84
14.68 Kwhr per Gallon of Fuel Oil ..... Nov *88
Freezeproofing and Corrosion, Coal ..... May 57
Freezeproofing Chemicals, This Plant Traces Corrosion to Coal ..... May *58
Freezeproofing of Coal for Utility Boilers, Use of Chloride Salts for ..... May 57
Frequency Relays Disconnect Synchronous Motors Under High Speed Reclosure ..... July *82
Frozen Coal ..... Sept 53
Fuel? Can They Use Molasses as a ..... Dec q 81
Fuel, Filters as ..... Sept 67
Fuel Oil Additives ..... PE Feb 85
Fuel Oil, 14.68 Kwhr per Gallon of ..... Nov *83
Fuel Oil Storage System, Planning Power Plant ..... June *66
Fuel Purchasing, Chart Simplifies ..... Dec *63
Fuels, Characteristics of Unusual Waste ..... June 59
Fuels, Synthetic Liquid ..... Jan EP 8
Fuels? What Does It Cost You To Burn Waste ..... Nov 90
Fuse? Why is This Circuit Grounded Through a ..... Aug q 78
..... Oct 80
..... Nov 79
..... Dec 81


# G


Gage, Absolute Pressure ..... Sept *44
Gage, Air Pressure ..... Oct 46
Gage, Pressure ..... Sept *48
Gage, Strain ..... Mar *62
Gallon of Fuel Oil, 14.68 kwhr per ..... Nov. *88
Gas Pipeline News ..... Oct EP 8
Gas Tables—Thermodynamic Properties of Air, Products of Combustion and Component Gases ..... May BR 128
Gas Turbine Developments in 1948 ..... Jan 68
Gas Turbine For Power Generation Stands in 1949—a Progress Report, Where the ..... July *102
Gas Turbine Opens New Chapter in Power Generation, Huey Station ..... Dec *54
Gas Turbines, Information on ..... Feb EP 7
Gas Washing Unit ..... Jan EP 8
Gasket, Flexible Metal ..... Nov *48
Gasket Made the Feed Pump Balk, How a Bad ..... PE Feb *89
Gear, Decanting ..... Apr *48
Generation, Huey Station Gas Turbine Opens New Chapter in Power ..... Dec *54
Generation Present and Future, Power ..... Jan *53
Generator, A Practical Thermoelectric ..... Aug *74
Generator Sets in Operation at P.G. & E., Twin 100,000-kw Turbine ..... June *61
Generator Sets, Motor ..... July *50
Generator Stand? How Much Phase Unbalance Can A ..... PE June q 75
..... Aug 79
..... Sep *79
Generator, Steam ..... Mar *56
Generator, Thoughts on a Practical Thermoelectric ..... Dec 53
Generator to Excite Snchro-cyclotron at Carnegie Tech, Homopolar ..... Nov *70
Generator, Vapor Steam ..... July *46
Generator? What Operating Data Should be Logged for a 1250-kw Condensing Turbine ..... Sept q 79
..... Oct 82
..... Nov *81
Generators, Packaged ..... Jan *44
Glenzip Zipper Repair Tool ..... Feb EP 7
Gobble-de-gook ..... Jan EP 7
Goes on the Line, Port Washington No. 3 ..... Mar *66
Goggle, Headrest ..... Apr 50
Goodyear Builds New Boiler Plant at Jackson ..... Apr *90
Governor, Throttling ..... July *48
Governors, About Hydraulic Turbine ..... Oct *59
Graham, David P. ..... Feb 98
Granby, New and Unusual Pumping Problems in Design and Operation of ..... July *86
Grand Coulee Dam ..... Aug EP 8
Grand Coulee Gets 12th Generator ..... Nov 96
Graphite Put Into Place at Brookhaven Atomic Pile, First ..... Jan 80
Greetings from Oscar ..... PE May *75
Grounded Through a Fuse? Why is This Circuit ..... Aug q 78
..... Oct 80
..... Nov 79
..... Dec 81
Grounding Neutrals ..... Sept 53
Grounds on 480-v, 3-phase Delta System; Locating ..... Sept *60
Guarantees Worth? What Are Fan ..... Oct *62
Guards, Wire ..... June *48
Guillotine, Hydraulic ..... Dec 42
Gumout "Diesel" ..... Apr 42
Gun, Steam ..... Mar *60


# H


Halsey, William D. ..... Jan 112
Handbook of Industrial Electronic Circuits ..... June BR 128
Handling Coal by Tractor Equipment ..... Mar *70
Handtool Fastens Steel to Steel, Powder-Actuated ..... PE Feb *86
Harbor Steam Plant, Unit No. 5 on the Line at ..... Oct. *102
Hardness Eliminates False End Points, New Versenate Test for Total Water ..... Dec *79
Hazards With Metallic Tapes, Rules; Electrical ..... Nov 77
He Came Ashore—He Saw—He Was Conquered—He Went Right Back to Sea! ..... PE Feb 90
He Wants Help on Power Plant Maintenance Schedules ..... PE Feb 91
..... PE Apr 86
Heads the Energy Parade, Coal Still ..... Jan *57
Health Protection, Radiation Detection for ..... Oct 77
Heat Balance in Improving Industrial Power Plants, How to Use ..... Mar *102
Heat Exchanger ..... Dec *50
Heat Exchangers ..... Jan *48
Heat Pump Works, How the ..... Nov *87
Heat Transfer ..... Oct BR 112
Heat Where It Belongs—At the Tip, How to Keep Soldering Iron ..... Sept 81
Heater, Gas-Fired Unit ..... Jan *42
Heater, Unit ..... Feb *42
..... Mar *54
Heating Pays—Why Don't We Have More of It? Central ..... Dec *88
Heating, Reducing Waste in the Use of Low-Pressure Steam for ..... PE Jan *85
Heating System Adequate and Economical? Is Your ..... Aug 92
Heating, Ventilating and Air Conditioning Guide ..... Oct BR 112
Help This Engineer Pump Cold Molasses? Who Can ..... PE June q 75
..... Aug 79
..... Dec 80
Hickling Station ..... Dec *57
High-Voltage Engineering Laboratory at Pittsfield, New ..... Sept *66
Hiwassee Valley Projects, The Technical Report No. 5, Volume 2 ..... May BR 120
Hoist, Lightweight ..... Apr *50
Homes, Building Their ..... Mar EP 7
Homopolar Generator to Excite Synchrocyclotron at Carnegie Tech ..... Nov *70
Horizontal Engines ..... Nov *50
Hose, Heavy Duty Fire ..... Aug 48
Hose, Rubber Spray ..... Sept 44
Hot-Process Lime-Soda Effluent, New Approach to Secondary Treatment of ..... Oct *75
How to Cut Good Threads by Hand ..... PE Mar *90
How to Prevent Ion Leakage in Exchange Treatment of Feedwater ..... May *86
How to Solve Problems in Steam Power Engineering ..... Sept BR 128
How to Use Heat Balance in Improving Industrial Power Plants ..... Mar *102
How We Fixed the Turning Liner That Stopped the Air Pump ..... PE Apr 85
Huey Station Gas Turbine Opens New Chapter in Power Generation ..... Dec *54
Human Factor, The ..... PE Feb 89
Human Relations, American Industry Can Lead the World in ..... Feb *53
Humidity Equipment ..... Dec *46
Humidity, Simplify your Calculations for Air Compression and Humidity ..... May *70
Hutchings Station Now Serves Dayton—Designed for Economy and Dependability, O. H. ..... Feb *54
Hutchings Station, Ventilation at O. H. ..... Dec *76
Hydraulic Guillotine ..... Dec 42
Hydraulic Sheave Drive ..... Sept *48
Hydraulic Turbine Governors, About ..... Oct *59
Hydraulic Turbine Runners, Cleaning Large ..... Nov *67
Hydroelectric Equipment, Metallizing Repairs on ..... Dec *92
Hydro-Irrigation Scheme, Australia Plans New ..... July 79
Hydro Power Development in New England, Study ..... Oct 69
Hydrocol Process Requires 80,000 hp in Compressors ..... Aug *61


# I


Idlers, Impact ..... May *50
Illuminators, Gage ..... Aug 42
Immediate Medical Attention in Solvent Illness ..... May 69
Impact Tool ..... Jan *48
Increasing Refrigeration Capacity When Power Can't Be Bought ..... PE Feb 88
India—first newsprint mill ..... Feb EP 8

Indicator, Flashover ..... Oct *46
Indicator, Smoke ..... Apr *46
..... May 42
Indicators ..... Mar 62
Industrial Applications for Rotating Regulators ..... Apr *66
Industrial Cyclone Burner Units, Dow Installs First ..... Mar *78
Industrial Electricity, Volume II, Alternating Currents ..... June BR 128
Industrial Power, Britain's ..... Oct *84
Industrial Power Plant, Take a New Look at Your ..... Sept *94
Industrial Power Plant With No Outside Power, Starting Up a New ..... July *64
Industrial Power Plants, How to Use Heat Balance in Improving ..... May *102
Industrial Process Instruments in Power Plant Control, How We Use ..... Aug *81
Industrial Steam Turbines, Oil Systems for ..... Apr *58
..... May *60
Industrial Steam Turbines, Theses Tests Help You Get the Right Oil for ..... June *77
Industrial Steam Turbine Oil Systems for Best Oil Performance, How to Operate ..... Aug *65
Industry Can Lead the World in Human Relations, American ..... Feb *53
Inexpensive Air Cleaner ..... PE Feb 87
Influence Factor and What to Do About It, Telephone ..... Dec *68
Injury or Treatment, Electric Shock—Can Be Either ..... Dec *96
Instrument Valves ..... Dec *42
Introduction to Atomic Physics ..... Dec BR 104
Introduction to Radiochemistry ..... Dec. MR 104
Instruments in Power Plant Control, How We Use Industrial Process ..... Aug *81
Instruments, Panel ..... Sept 42
Insulation of Modern Waterwalls ..... Oct *72
Insulation Products ..... Nov 48
Intelligent Instruments, Mechanical Muscles— ..... Sept 58
Insulated with Mineral Wool, Large Chimney ..... PE Apr 85
Insulating Bushing ..... Jan *50
Insulation Tester ..... May 46
Interest in One's Work? Does it Pay to Take an ..... PE Jan 87
Internal-Combustion engine ignition system ..... June EP 7
Internal Combustion Engines, Recirculation Cooling System for ..... PE Apr *81
Inverted Check ..... Jan EP 7
..... Apr EP 7
Iola, Kansas; New 3000-kw Power Plant at ..... Nov *84
Ion Exchange Resins Work, How ..... Feb *94
Ion Exchangers, Tips for Operators on Backwashing ..... June *60
Ion Leakage in Exchange Treatment of Feedwater, How to Prevent ..... May *86
Iron In Ungava and Labrador ..... EP July 7
Iron, Soldering ..... Mar *62


## J


Jackson, Goodyear Builds New Boiler Plant at ..... Apr *90
Jacoby, Arthur L. ..... Oct 116
Jingles Joe, The Faith of ..... Aug *96
Joint, Pipe ..... Apr *48
Jones & Laughlin's New 1,000,000-lb-per-hr Steam Plant ..... Oct *54


## K


Keep your Flashlight in Working Order ..... PE Mar *96


## L


Laboratory at Pittsfield, New High-Voltage Engineering ..... Sept *66
Laborer's Criticism of Engineering Education, A ..... Nov 76
Ladder? How Do You Test a ..... Dec q 80
Land Surveys, Map and Titles; Your ..... EP July 7
Large Chimney Insulated with Mineral Wool ..... PE Apr 85
Large Electrical Machines, Vaporization Cooling of ..... May *67
..... Sept *82
Largest Turbine Factory, The World's ..... Apr. *77
Lawrence, William H. ..... Sept 100
Leakage? How Measure Compressed Air System? ..... PE Feb q 91
..... PE Apr 86
..... PE May 82
Let the Flexibility Prism Help You Analyze Pipe Stress ..... Dec *58
Light, Note on the Speed of ..... PE Jan 89
Lightning, Creeping—The Case of the ..... PE Apr *82
Lime-Soda Effluent, New Approach to Secondary Treatment of Hot-Process ..... Oct *75
Limiting Device, Speed ..... Sept *42
Lined Valve, Rubber ..... Dec *46
Liner, Duct ..... Apr 44
Liner That Stopped the Air Pump, How We Fixed the Turning ..... PE Apr 85
Lining Material ..... Sept 48
Liquid Level Control ..... May *50
..... June *46
Lithium-Hydrogen Reaction, Don't Forget the ..... Apr *74
Lloyd, William ..... Sept 100
Locate Faulty Joints in Overhead Lines, Device to ..... PE Feb 87
Locating Grounds on 480-v, 3-phase Delta Systems ..... Sept *60
Log Log Slide Rule ..... Oct *42
Logged for a 1250-kw Condensing Turbine Generator? What Operating Data Should be ..... Sept q 79
..... Oct. 82
..... Nov *81
Look at Your Industrial Power Plant, Take a New ..... Sept *94
Loosener, Parts ..... Nov 48
Low-grade iron ores ..... June EP 7
Low-Pressure Steam for Heating, Reducing Waste in the Use of ..... PE Jan *85
Lubricant, Compressible ..... Nov *50
Lubricant, Dry ..... Aug 50
Lubricants, Reclaimed ..... Aug 53


## M


Magnet Materials ..... Oct 50
Magnetic Plugs ..... Sept 46
Magnetic Starters ..... Jan *44
Magnets, Plate ..... Oct *46
Maintenance Costs in the Power Plant, Metallizing Reduces ..... PE Apr *78
Maintenance of Electronic Regulators ..... Mar *73
Maintenance Man is Bitter on Sunday, Why the ..... Oct 96
Maintenance Method Cuts I. D. Fan Outage from 1 Week to 16 hr at Delray, New ..... Sept *62
Maintenance of Mechanical Voltage Regulators, Operation and ..... Nov *60
Maintenance Schedules, He Wants Help on Power Plant ..... PE Feb 91
..... PE Apr 86
Make-Up Water Feeder ..... Oct *44
Manometer, Mercury ..... Jan *46
Manometer Tables, Tentative Recommended Practices, RP2.1 ..... May BR 124
Manufacture of Titanium Metal ..... Feb EP 7
Marti, Othmar K. ..... Apr 96
Measure Compressed Air System Leakage? How ..... PE Feb q 91
..... PE Apr 86
..... PE May 82
Mechanical engineering for a woman ..... Mar EP 8
Mechanical Muscles — Intelligent Instruments ..... Sept 58
Mechanical Voltage Regulators, Operation and Maintenance of ..... Nov *60
Medical Attention in Solvent Illness, Immediate ..... May 69
Medicine and engineering in submarines ..... EP Sept 8
Meltable Rubber ..... EP Nov 7
Men Behind Your Products, The ..... Mar *65
Metal Primer ..... Dec 50
Metallizing Reduces Maintenance Costs in The Power Plant ..... PE Apr *78
Metallizing Repairs on Hydroelectric Equipment ..... Dec. *92
Metallic Tapes, Rules; Electrical Hazards With ..... Nov 77
Metallurgy ..... May 53
Metals, Influence of temperature on ..... Jan EP 8
Meter, Alarm ..... Nov *48
Meter, Combination ..... Jan *46
Meter, Combination ..... June 46
Meter, Flux ..... Jan 42
Meter, Oxygen ..... May *44
Meter, Precision Air ..... Sept *50
Method Cuts I. D. Fan Outage from 1 Week to 16 hr at Delray; New Maintenance ..... Sept *62
Microwave Relay Control System for Southern California Edison ..... Dec 87
Midwest Power Conference, Preliminary Program, Eleventh Annual Meeting ..... Apr 92
Midwest Power Conference, 11th ..... June 61
Milepost of Progress, Sewaren— ..... July *66
Milk a Mouse, How to ..... July *78
Mine Hoist Drive, Power Supply Affects Choice of ..... Dec *64
Mining for oil ..... May EP 8
Mobile Use, Nuclear Power for ..... Feb *78
Modern Industrial Construction ..... Nov BR 110
Molasses as a Fuel? Can They Use ..... Dec q 81
Molasses? Who Can Help This Engineer Pump Cold ..... PE June q 75
..... Aug 79
..... Dec 80
Money by Raising Steam Temperature, We Saved ..... PE May 76
Monitoring at Sewaren, Centralized Automatic Temperature ..... Oct *70
Morse III, Charles Hosmer ..... Aug 116
Most Desirable Personel Characteristics, The ..... Oct BR 132
Motive, Steam and Power for Electro— ..... Sept *76
Motor Control, High Voltage ..... Aug *58
Motor Drive, World's Most Powerful ..... Feb *69
Motor, Feedwater Pump ..... July *44
Motor Operator, Fluid ..... Aug *48
Motor, Pump ..... Mar *58
Motor Rotor Operate Off Center? Why Did ..... Aug q 78
..... Oct 81
..... Dec 81
Motor Voltage Be Varied Without Damage? How Much Can Applied ..... PE Apr q 86
..... June 75
Motor, Wound Rotor ..... Sept *44
Motors, Drip-Proof ..... Feb *50
Motors, Fluid-Shaft ..... Oct *42
Motors, FHP ..... May 48
Motors, Induction ..... Feb *44
Motors, Unit Cooled D-C ..... June *46
Mounts, Vibration ..... Nov *46
Mouse, How to Milk a ..... July *78
Mouse Milk ..... Jan EP 7
..... EP July 7
Moving Six Marine Boilers to Texas City ..... Feb *73


## N


National Conference on Industrial Hydraulics Proceedings ..... July BR 128
National Power Show, Grand Central Palace, New York; 18th ..... Jan *76
Negative Spring ..... Sept *46
Neutrals, Grounding ..... Sept 53
New and Unusual Pumping Problems in Design and Operation of Granby ..... July *86
New in the Electrical Art? What's ..... Mar *82
New Johnsonville steam plant ..... EP Oct 8
News Reel, Power Generation ..... July *62
..... Aug *68
..... Sept *68
..... Oct *78
..... Nov *68
..... Dec *72
1949 Supplement to Lincoln's Electrical Reference Book ..... Sept BR 128
Nipple Cause Safety Valve to Blow Incorrectly? Why did ..... PE Jan q 90
..... PE Mar 100
..... PE May 83
Non-Skid Floor Plate ..... Dec *50
Note on the Speed of Light ..... PE Jan 89
Nuclear Forces ..... Dec BR 108
Nuclear Power for Mobile Use ..... Feb *78
Nuclear Radiation Physics ..... Aug BR 127
Nuclear Reactor for Ship Propulsion, Westinghouse to Develop ..... Feb 81
Nuclear Reactors for Power ..... July 81
Nut, Automatic Locking ..... Oct. 50


## O


Oakdale Plant for Newport Industries, Soft Water Hardened at ..... Jan. *81
Observations on Spreader Stokers and Combustion Equipment, Some ..... June *88
Occupational Diseases of the Skin in the Electrical Industry ..... PE Mar 92
Oil, Cloudy ..... PE Apr 84
Oil made from coal ..... June EP 7
Oil Removal Process ..... Dec *50
Oil Storage System, Planning Power Plant Fuel ..... June *66
Oil Systems for Industrial Steam Turbines ..... Apr *58
..... May *60
..... June *77
..... Aug *65
Oil Testing Kit, Lubricating ..... Feb *46
Oil Treatment, Fuel ..... May 50
Oiler, Wick ..... Mar 56
Old Dutch Pumping Stations ..... PE Jan *82
100 in. HG ..... Nov 53
1,000,000-lb-per-hr Steam Plant, Jones & Laughlin's New ..... Oct *54
Operate Off Center? Why Did Motor Rotor ..... Aug q 78
..... Oct 81
..... Dec 81

Operating Air Pressure Influence Pneumatic Control Systems, How Tankage and....Feb *62
Operating Data Should Be Logged for a 1250-kw Condensing Turbine Generator? What ....Sept q 79
....Oct 82
....Nov *81
Operating Engineers in Cleveland, Here's How They Train Power Plant ....Aug *70
Operation and Maintenance of Mechanical Voltage Regulators..Nov *60
Oscar, Greetings From....PE May *75
Oxygen Meter ....May *44


# P


P. G. & E., Twin 100,000-kw Turbine Generator Sets in Operation at ....June *64
Packing for Boiler Feed Pumps, Wood-Metal ....PE May *74
Packing, Piston Ring....Oct 46
Packing, Wood-Metal ....July *44
Paging System, Silent....May 48
Paint, Fire Retardant....Apr 50
Paint Spray Unit ....June *44
Panalarms ....Mar *60
Panel Board ....Aug *42
Panelboard, Low Cost....Nov *46
Panel Instruments ....Nov *46
Papers Presented at the Seventh Short Course in Coal Utilization ....Sept BR 128
Papers Presented at the First Short Course on Hot Water and Steam Heating Systems....Sept BR 128
Patent Law ....June BR 128
Patent Law for the Executive and Engineer ....July BR 128
Paving Breaker ....June 46
Petoskey Hydro, Three 1440-hp Diesels Quadruple ....June *57
Petroleum Products, Calculated for Volumes of Oil and Other ....PE May *77
Phase Unbalance Can a Generator Stand? How Much ....June q 75
....Aug 79
....Sept *79
Photoelectric Cells ....June 48
Photoelectric Control ....May *46
Photoelectric Unit ....Apr *44
Physics in the Modern World..Dec BR 110
Pike's Peak, Power from....Aug *62
Pinch Valve, Rubber ....Dec *42
Pipe Alignment ....Aug *112
Pipe and Bolt Machine....June *48
Pipe for Close Level Control? How Design Overflow ....PE Feb q 91
....PE Apr *87
Pipe Sizing—Steam and Water Flow, Pressure Drop, Pipe Size; These Tables Speed Up....July *54
Pipe Stress, Let the Flexibility Prism Help You Analyze ....Dec *58
Pipe Threads ....Aug 48
Pipe Wrenches ....Dec *44
Pipelines for television....EP Oct 8
Pipes, Finding Size of Filling and Equalizing ....PE Mar *99
Piston Rods Ever Bowed? Answer Yes or No!—Are ....PE May q 82
....July 76
Piston Valves on Uniflow Engine? What is Best Length for Adjustable ....PE Jan q 90
Placing A New Refrigerating Plant in Service....Apr *62
Planning Power Plant Fuel Oil Storage System ....June *66
Plant at Decatur, Staley Expands Power ....May *54
Plant at Jackson, Goodyear Builds New Boiler....Apr *90
Plant at Iola, Kansas; New 3000-kw Power ....Nov *84
Plant, Electric ....Aug 44
Plant Features Automatic Control, Cuban Power....July *96
Plant in Service, Placing A New Refrigerating ....Apr *62
Plant, Jones & Laughlin's New 1,000,000-lb-per-hr Steam ....Oct *54
Plant Traces Corrosion to Coal Freezeproofing Chemicals, This....May *58
Plant Wash-Water By Using Wasted Condensate, Increasing Power ....Aug *60
Plant With No Outside Power, Starting Up a New Industrial Power ....July *64
Plants and Their Equipment, Designing Safety into Power....Apr *54
Plate, Non-Skid Floor ....Dec *50
Plier, Self-Locking ....Jan 50
Pliers, Electric ....June *42
Plugs, Extractor for Economizer Tube ....Sept *65
Plugs, Magnetic ....Sept 46
Pneumatic Control Systems, How Tankage and Operating Air Pressure Influence ....Feb *62
Points, New Versenate Test for Total Water Hardness Eliminates False End ....Dec *79
Polaroid Land camera....June EP 8
Polyphase Meter ....Apr *48
Pope, Albert A....Jan 114
Port Washington No. 3 Goes on the Line ....Mar *66
Powder-Actuated Handtool Fastens Steel to Steel....PE Feb *86
Powder Extinguisher ....Mar 58
Power and Fuel Supply, Atomic....Nov 75
Power and Its Implication for Aircraft Propulsion, Atomic....Sept 78
Power Development in New England, Study Hydro....Oct 69
Power Development in the U. S. in 1948, Electric....Jan *54
Power for Alford's New 17-Acre Warehouse in Dallas, Refrigeration and ....Sept *90
Power for Electro-Motive, Steam and ....Sept *76
Power for More California People; More ....Sept *61
Power from Pike's Peak....Aug *62
Power Generation, Huey Station Gas Turbine Opens New Chapter in ....Dec *54
Power Generation Present and Future ....Jan *53
Power Generation, Twin Branch—A Study of Progress in....Nov *54
Power, Nuclear Reactors for....July 81
Power Plant at Decatur, Staley Expands ....May *54
Power Plant at Iola, Kansas, New 3000-kw ....Nov *84
Power Plant? Can We Use A Cadmium Storage Battery for a ....July q 76
....Sept. 80
....Nov 78
Power Plant Control, How We Use Industrial Process Instruments in ....Aug *81
Power Plant Features Automatic Control, Cuban ....July *96
Power Plant Figuring—I, Basic ....PE Feb *82
....PE Mar *94
....PE Apr 82
....PE May *78
....June 59
....July *60
....Aug 72
....Sept *74
....Oct *86
....Nov *53
....Nov *82
....Dec *74
Power Plant Fuel Oil Storage System, Planning ....June *66
Power Plant, Metallizing Reduces Maintenance Costs in The....PE Apr *78
Power Plant Maintenance Schedules, He Wants Help on ....PE Feb 91
....PE Apr 86
Power Plant Operating Engineers in Cleveland, Here's How They Train ....Aug *70
Power Plant, Take a New Look at Your Industrial ....Sept *94
Power Plant Wash-Water By Using Wasted Condensate, Increasing ....Aug *60
Power Plant With No Outside Power, Starting Up a New Industrial ....July *64
Power Plants and their Equipment, Designing Safety into....Apr *54
Power Plants, Boiler Feed Pump Operation in 2-Unit....Nov *72
Power Plants, How to Use Heat Balance in Improving Industrial ....Mar *102
Power Potential Being Overlooked? Is Alaska's....Aug *88
Power Show, Grand Central Palace, New York; 18th National..Jan *76
Power Stations and Equipment, Developments of 1948 in....Jan *58
Power Supply Affects Choice of Mine Hoist Drive ....Dec *64
Power Supply Unit....Apr *44
Practical Tester for Radiator Trap Elements, A....PE Mar *98
Practical Thermoelectric Generator, A ....Aug *74
Practices? Why Continue These....Sept *64
Preheater, Bulk Tank....Oct *44
Preliminary Program, Eleventh Annual Meeting, Midwest Power Conference ....Apr 92
Presses? Should He Use Accumulator on Lines to Steam ....Dec q 80
Pressure Drop, Pipe Size; These Tables Speed Up Pipe Sizing—Steam and Water Flow....July *54
Pressure Gage, Air....Oct 46
Pressure Reducing ....Oct 87
Pressures Held Constant, How Can You Increase Refrigeration? With ....June q 75
....Aug 80
Prevent Ion Leakage in Exchange Treatment of Feedwater, How to ....May *86
Prevents Slag on Boiler Heating Surfaces, Protective Coating....July 74
Primer, Metal ....Dec 50
Principles and Methods of Telemetering ....May BR 122
Principles of Servomechanisms ....May BR 126
Printing Plates ....Apr EP 8
Prism Help You Analyze Pipe Stress, Let the Flexibility ....Dec *58
Problem? Will a Rectifier Solve This ....PE Feb *92
Process Instruments in Power Plant Control, How We Use Industrial ....Aug *81
Process, Oil Removal ....Dec *50
Process Requires 80,000 hp in Compressors, Hydrocol ....Aug *61
Products, The Men Behind Your....Mar *65
Progress in Power Generation, Twin Branch—A Study of....Nov *54
Progress—phooey! ....Apr EP 8
Protective Coating Prevents Slag on Boiler Heating Surfaces....July 74
Protector, Lighting ....Apr 48
Puller, Three-Jaw ....Apr *50
Pulleys, Magnetic ....May 50
Pulverized Coal Explosion....Nov *86
Pulverized Coal Filters, Automatic Fire Protection for....May *84
Pump Balk, How A Bad Gasket Made the Feed....PE Feb *89
Pump, Centrifugal ....Aug *50
Pump Cold Molasses? Who Can Help This Engineer ....PE June q 75
....Aug 79
....Dec 80
Pump, Condensation ....Feb *50
Pump, Cycling Jet....Oct *48
Pump Efficiencies? How Can He Compare Simplex and Duplex ....PE May q 82
....July 77
....Aug 78
Pump Motor ....Mar *58
Pump Operation in 2-Unit Power Plants, Boiler Feed....Nov *72
Pump, Sump ....Nov 46
Pump, Variable Volume ....Dec *48
Pump Works . . . How the Heat....Nov *87
Pumping Problems in Design and Operation of Granby, New and Unusual ....July *86
Pumps, Centrifugal ....July *48
....Aug *42
Pumps, Cradle Mounted....Aug *46
Pumps, Direct Flow ....Dec *44
Pumps, New ....Sept *48
Pumps, Rotary ....Aug 44
Pumps, Wood-Metal Packing for Boiler Feed ....PE May *74
Purchasing, Chart Simplifies Fuel..Dec *63
Purifier, Air-Steam Line....Nov *44
Pyrometer, Continuous ....July *42
Pyrometer, Indicating ....May 50
Pyrometer, Portable ....Nov 50


# Q


Q.E.D., M.I.T. in World War II ....May BR 124
Queer Quirks ....July 53


# R


Radiation Detection for Health Protection ....Oct 77
Radiator Trap Elements, A Practical Tester for....PE Mar 98
Radioactive Piston Rings....Mar EP 8
Radioactive Tracer Techniques..Dec BR 104
Raising Steam Temperature, We Saved Money by....PE May 76
Ratio Test Set, Transformer Turn..Feb *48
Reaction, Don't Forget the Lithium-Hydrogen ....Apr *74
Reactions, Temperature and Nuclear ....Aug 110
Reburning Stoker Fly Ash....June *54
Recirculation Cooling System for Internal Combustion Engines ....PE Apr *81
Reclaimed Lubricant ....Aug 53
Recording Instrument ....Apr *42
Records 160 Temperatures, Indicates ....Jan *44
Rectifier Cell ....June *50
Rectifier, Selenium ....Nov *44
Rectifier Solve This Problem? Will a ....PE Feb *92
Rectifiers Announced, Selenium....Feb *46
Rectifiers, Selenium ....Aug *46
Re-Design, Economizer ....Oct 53
Reducer, Speed ....Jan *48
Reduces Maintenance Costs in The Power Plant, Metallizing ....PE Apr *78
Reducing Boiler Sludge With a Silica Equilibrium ....Mar *76
....Apr *69
Reducing, Pressure ....Oct 87
Reducing Waste in the Use of Low-Pressure Steam for Heating ....PE Jan *85
Refractory Enclosures Behind Waterwalls ....Dec *86
Refractory, Plastic ....Oct 44

Refrigeration and Power for Alford's New 17-Acre Warehouse in Dallas ..... Sept *90
Refrigeration Capacity When Power Can't Be Bought, Increasing ..... PE Feb 88
Refrigerating Plant in Service, Placing a New ..... Apr *62
Refrigeration Plant? Who Knows About Incentive Bonus Systems for Ammonia ..... PE Jan 91
Refrigeration? With Pressures Held Constant, How Can You Increase ..... June q 75
..... Aug 80
Refuse, Wood—A Stoker for ..... Apr *72
Registers Demand ..... Mar *60
Regulator, Fluid ..... Oct 44
Regulators, Industrial Applications of Rotating ..... Apr *66
Regulators Can Do For You, What Rotating ..... June *81
Regulators, Maintenance of Electronic ..... Mar *73
Regulators, Operation and Maintenance of Mechanical Voltage ..... Nov *60
Relay, Differential ..... Mar 58
Relay, Drawout ..... Mar *54
Relays Disconnect Synchronous Motors Under High Speed Reclosure, Frequency ..... July *82
Relays, Mercury ..... Jan *46
Remote Control Unit ..... Aug *77
Repairs on Hydroelectric Equipment, Metallizing ..... Dec *92
Report on Oil Engine Power Cost for 1947 ..... May BR 128
Reserve Coal Storage Now? Need ..... Feb *70
Resins Work, How Ion Exchange ..... Feb *94
Revolution on the Skyline ..... EP Oct 7
Rings, Self-Lubricating ..... Feb 44
Rocket and Jet Propulsion Study ..... EP Apr 8
Rods, Zinc ..... Mar 60
Rotameter, Multi-Flow ..... July *44
Rotating Regulators Can Do For You, What ..... June *81
Rotochute ..... Mar EP 8
Rotor Operate Off Center? Why Did Motor ..... Aug q 78
..... Oct 81
..... Dec 81
Rotors Without Special Equipment, Balancing ..... Nov *94
Rule, Slide ..... Mar 56
Runners, Cleaning Large Hydraulic Turbine ..... Nov *67


## S


Safeguard, Combustion ..... July *46
Safeguard, Flame Failure ..... Feb *44
Safeguard, Photoelectric ..... Aug *48
Safety into Power Plants and their Equipment, Designing ..... Apr *54
Safety Valves and They'll Take Care of You, Take Care of Your ..... July *90
Sample Cooler ..... Jan 50
Saved Money by Raising Steam Temperature, We ..... PE May 76
Saw, Air-Powered Pipe ..... July *50
Scale and Corrosion in Drinking Water Systems? What Treatments Prevent ..... July q 76
..... Sept 80
..... Oct 80
Scale, Coal ..... July *42
Scale Thickness Indicator, Forestall Boiler Tube Failures by Using This ..... June *58
Schedules, He Wants Help on Power Plant Maintenance ..... PE Feb 91
..... PE Apr 86
Schiemann, Elmore H ..... Apr 96
Screens, Vibrating ..... May 50
Secondary Treatment of Hot-Process Lime-Soda Effluent, New Approach to ..... Oct *75
Selecting Power Cables to Meet Short-Circuit Requirements ..... Feb *64
Selector, Strap ..... Apr 50
Separator ..... May 48
Separator, Magnetic ..... Sept *44
Sequence Control ..... June 46
Serendipity ..... Aug EP 7
74-Wheel Trailer Carries 100,000-kw Generator ..... Feb *68
Sewaren, Centralized Automatic Temperature Monitoring at ..... Oct *70
Sewaren—Milepost of Progress ..... July *66
Sferics ..... Jan EP 8
Shaft Currents in Alternating-Current Machinery ..... Nov *102
Shafting, How to Eliminate Static from ..... Sept 88
Shake-out Vibrators ..... Apr *42
Shaker, Car ..... Aug 42
..... Aug *44
Shale-oil refinery ..... Sept EP 8
Sharp Tools Save Labor; Make Jobs Easier ..... PE Jan *86
Shock—Can Be Either Injury or Treatment, Electric ..... Dec *96
Short-Circuit Requirements, Selecting Power Cables to Meet ..... Feb *64
Should He Use Accumulator on Lines to Steam Presses? ..... Dec q 80
Signal, Safety ..... Mar 62
Silencer, Alarm ..... Aug *46
Silica Equilibrium, Reducing Boiler Sludge With a ..... Mar *76
..... Apr *69
Simplifies Electrical Connections, Speed Nut Fastener ..... PE Jan *86
Simplify Your Calculations for Air Compression and Humidity ..... May *70
Simplifying Boiler Design by Eliminating Enshrouded Mystery ..... Feb *74
Single Cell of Living Matter ..... Sept EP 7
Size of Filling and Equalizing Pipes, Finding ..... PE Mar *99
Skin in the Electrical Industry, Occupational Diseases of the ..... PE Mar 92
Slag on Boiler Heating Surfaces, Protective Coating Prevents ..... July 74
Sleeve, Make Your Toggle Bolt Solid with a ..... Aug *94
Slide Rule ..... Mar 56
Slide Rule, Log Log ..... Oct *42
Sludge-Blanket Softeners at a Firestone Plant, Comparison of Conventional and ..... Sept *70
Smoke ..... June BR 128
Smoke Abatement ..... Mar EP 8
..... July *44
Smoke Control to Fit, We Tailored Our ..... July *56
Smoke Density Meter ..... Feb *48
Smoke Detector ..... Nov *44
Smoke Indicator ..... Jan *42
..... Apr *46
..... Oct *48
Smudge, A ..... Aug 112
Socket, Swivel ..... Aug *48
Sockets, Impact ..... Apr *50
Soft Water Hardened at Oakdale Plant of Newport Industries ..... Jan *81
Softeners at a Firestone Plant, Comparison of Conventional and Sludge-Blanket ..... Sept *70
Soldering Flux ..... Feb 50
Soldering Iron Heat Where It Belongs—At the Tip, How to Keep ..... Sept 81
Solenoid Valves ..... Dec *46
Solvent Cleaning and Boiler Design—I ..... Jan *69
..... Feb *59
Sound Measurements ..... Nov EP 8
Sources of Engineering Information ..... Nov BR 110
Southern California Edison, Microwave Relay Control System for ..... Dec 87
Speed Indicator, Fan ..... July *84
Speed Nut Fastener Simplifies Electrical Connections ..... PE Jan *86
Speed Reducer, Vertical ..... June 44
Spoof, Superheat ..... PE Jan 89
Spray Unit, Paint ..... June *44
Spreader Stoker, Details of New F & E ..... Jan *94
Spreader Stoker Stands Today, Where the ..... Nov *64
Spreader Stokers and Combustion Equipment, Some Observations on ..... June *88
Spring, Negative ..... Sept *46
Spring Supports? Now Calculate Condenser ..... PE Jan *90
..... PE Mar 99
Stacks, Control of Aircraft Warning Lights on ..... July 84
Staley Expands Power Plant at Decatur ..... May *54
Standard Handbook for Electric Engineers ..... June BR 128
Standard Welding Terms and Their Definition; also Standard Master Chart of Welding Processes and Process Charts ..... Aug BR 132
Standards, Definitions and Terms in use by the Fan and Blower Industry ..... Feb EP 7
Standards of Hydraulic Institute ..... May BR 128
Standards? What Good are ..... Mar EP 8
Starter, Electronic ..... Dec 50
Starter, Engine ..... Feb *48
Starter, Full-Voltage ..... Nov *42
Starters, A-C ..... Nov *42
Starters, Across-the-Line ..... July *48
Starters, Magnetic ..... Jan *44
Starting Up a New Industrial Power Plant With No Outside Power ..... July *64
Static from Shafting, How to Eliminate ..... Sept 88
Station Now Serves Dayton—Designed for Economy and Dependability, O. H. Hutchings ..... Feb *54
Station, Ventilation at O. H. Hutchings ..... Dec *76
Stations and Equipment, Developments of 1948 in Power ..... Jan *58
Steam and Power for Electro-Motive ..... Sept *76
Steam and Water Flow, Pressure Drop, Pipe Size; These Tables Speed Up Pipe Sizing ..... July *54
Steam Plant, Unit No. 5 on the Line at Harbor ..... Oct 102
Steam Presses? Should He Use Accumulator on Lines to ..... Dec q 80
Steam Saves 800 Tons of Coal Annually, Use of Exhaust ..... July *79
Steam Turbine Oil Systems for Best Oil Performance, How to Operate Industrial ..... Aug *65
Steel Expansion Joint, How We Arc-Welded a ..... Aug *57
Steel—423 F ..... Sept EP 7
Steel Industry—capacity and output, The ..... Mar EP 7
Steel Making in America ..... Aug EP 7
Steam Load Warning ..... PE Apr *85
Steam Turbines, Oil Systems for Industrial ..... May *60
Still Going Strong, Fifty Years Old— ..... PE May *81
Stocking-Out Conveyor for Cahokia, New ..... Jan 94
Stoker Fly Ash, Reburning ..... June *54
Stoker for Wood Refuse, A ..... Apr *72
Stoker, Spreader ..... Aug 50
Stoker Stands Today, Where the Spreader ..... Nov *64
Stoker Units, Boiler ..... Nov *48
Stokers and Combustion Equipment, Some Observations on Spreader ..... June *88
Storage Container ..... Dec *44
Storage System, Planning Power Plant Fuel Oil ..... June *66
Storage Now? Need Reserve Coal ..... Feb *70
Strain Gage Devices ..... Feb EP 7
Strainer, Duplex ..... Jan *44
Strainer, Y-Type ..... Dec *46
Strainers, Twin ..... Aug *42
Strange Story of the Quantum, The ..... Sept BR 128
Stripper, Cable ..... Dec *50
Stroboscope ..... June *42
Stud Puller, New ..... Feb *42
Study of Registration of Professional Engineers ..... May EP 7
Substation, Unit ..... Sept *46
Superheat Spoof ..... PE Jan 89
Supply Affects Choice of Mine Hoist Drive, Power ..... Dec *64
Supports? How Calculate Condenser Spring ..... PE Jan *90
..... PE Mar 99
Suspended Walls ..... Oct *44
Switch Engines, Improved ..... Jan 50
Switch, Tank Float ..... Oct *46
Switch, Weatherproof ..... Oct 50
Switching-Cutout Device ..... June *48
Switching Mechanism ..... June 46
Swivel, Wire Rope ..... Nov *46
Synchro-cyclotron at Carnegie Tech, Homopolar Generator to Excite ..... Nov *70
Synchronous Motors Under High Speed Reclosure, Frequency Relays Disconnect ..... July *82
Synthetic liquid fuels ..... May EP 7
System Adequate and Economical? Is Your Heating ..... Aug 92
System Eliminates Radio Interference With Inert Arc Welding, New ..... PE Feb *87


## T


Tables Speed Up Pipe Sizing—Steam and Water Flow, Pressure Drop, Pipe Size; These ..... July *54
Tachometer and Cutmeter ..... Dec *44
Tachometer, Miniature ..... Sept *50
Tachometer, Precision ..... July *46
..... Aug *46
Tacubaya Diesels Burn Heavy Fuel Oil ..... Sept *59
Tailored Our Smoke Control to Fit, We ..... July *56
Take a New Look at Your Industrial Power Plant ..... Sept *94
Take Care of Your Safety Valves and They'll Take Care of You ..... July *90
Tank Preheater, Bulk ..... Oct *44
Tankage and Operating Air Pressure Influence Pneumatic Control Systems ..... Feb *62
Tape, Cork Filled ..... May *48
Tape, Electric Insulating ..... Jan 44
Tape, Electrical ..... July *50
Tape, Fish ..... June *46
Telephone Influence Factor and What to Do About It ..... Dec *68
Telescope, World's biggest ..... Jan EP 7
Television for combustion efficiency ..... Aug EP 7
Television Visual Education ..... July EP 7
Temperature and Nuclear Reactions, ..... Aug 110
Temperature Conversion Tables ..... PE Jan *92
Temperature Indicator, Recorder ..... Feb *50

Temperature Indicators ..... June *44
Temperature Monitoring at Sewaren, Centralized Automatic.... Oct *70
Temperature, Pressure Recorders.... Jan 48
Template, Public Utility..... Aug *50
Ten Years of Atomic Energy Development ..... Mar *86
Test a Ladder? How Do You .... Dec q 80
Test Paper Set ..... Oct 46
Tester, Armature ..... May *46
Tester for Radiator Trap Elements, A Practical ..... PE Mar *98
Tester, Insulation ..... June *48
Testing Kit, Portable..... Sept *50
Tests Help You Get the Right Oil for Industrial Steam Turbine, These ..... June *77
The Science and Engineering of Nuclear Power ..... June BR 128
Thermal Efficiency ..... Apr 53
Thermal Efficiency? What do You Mean by ..... PE Jan 87
Thermodynamic Charts for Combustion Process ..... Sept BR 128
Thermoelectric Generator, A Practical ..... Aug *74
Thermoelectric Generator, Thoughts on a Practical ..... Dec 53
Thermometer, Contact-Making..... Feb *42
Thickness Indicator, Forestall Boiler Tube Failures by Using this Scale ..... June *58
Thread Standards, Don't Worry About New ..... Nov *66
Threader, Pipe ..... Apr *48
Threader, Pipe and Bolt..... Sept *42
Threading Machine ..... Oct *50
Threads By Hand, How To Cut Good ..... PE Mar *90
Threads, Pipe ..... Aug 48
Three 1440-hp Diesels Quadruple Petoskey Hydro ..... June *57
3000-kw Power Plant at Iola, Kansas, New ..... Nov *84
300 Tons of Fly Ash Every Day? Where Would You Put ..... Dec *85
Thoughts on a Practical Thermoelectric Generator ..... Dec 53
Tilter, Carboy ..... July *50
Time-Power Source ..... May *24
Tips for Operators on Backwashing Ion Exchangers..... June *60
Toggle Bolt Solid with a Sleeve, Make Your ..... Aug *94
Tool Reseating ..... Mar *56
Tooling for white-collar workers, Better ..... Nov EP 8
Tools Save Labor; Make Jobs Easier, Sharp ..... PE Jan *86
Topping Program, Waterside Completes Its ..... May *62
Topping Program, Waterside Completes Its ..... Sept *54
Torch, Hand ..... Apr 50
Tower, Cooling ..... June *42
Tower, Water Cooling..... May *42
Tractor Equipment, Handling Coal by ..... Mar *70
Trailer Carries 100,000-kw Generator, 74-Wheel ..... Feb *68
Train Power Plant Operating Engineers in Cleveland, Here's How They ..... Aug *70
Training for Lubrication Engineers ..... Oct EP 8
Transformer ..... May *46
Transformer, Butyl-Molded ..... July *46
Transformer, Safety ..... Apr *46
Transformers ..... Mar *56
Transformers, Control ..... Mar *62
Transformers, Dry Type..... Aug *46
Transmitter, Pressure ..... Mar *60
Transmitter, Temperature ..... July *48
Trap, Continuous Flow..... May *42
Trap, Small Steam ..... Apr 44
Treatment, Anti-Foam ..... Aug 42
Treatment, Electric Shock—Can Be Either Injury or ..... Dec *96
Treatment, Fuel Oil..... May 50
Treatment of Hot-Process Lime-Soda Effluent, New Approach to Secondary ..... Oct *75
Treatments Prevent Scale and Corrosion in Drinking Water Systems? What ..... July q 76
..... Sept 80
..... Oct 80
Trouble With Engineers, The..... Oct 94
Tube Fitting ..... Nov *44
Tube, Flow ..... May 44
Turbine-Driven Compressors Supply Air for G-M Factory..... Aug *54
Turbine Factory, The World's Largest ..... Apr *77
Turbine for Power Generation Stands in 1949—a Progress Report, Where the Gas..... July *102
Turbine Generator Sets in Operation at P.G. & E. Twin 100,000-kw ..... June *64
Turbine Generator Set, How to Align a Four-Bearing..... PE Feb *84
Turbine Generator? What Operating Data Should be Logged for a 1250-kw Condensing ..... Sept q 79
..... Oct 82
..... Nov *81
Turbine Governors, About Hydraulic ..... Oct *59
Turbine No. 2 Drop Load and Lose Vacuum? What Makes .... Aug q 78
..... Oct 82
..... Dec 82
Turbine, Horizontal ..... Nov *48
Turbine Oil Systems for Best Oil Performance, How to Operate Industrial Steam ..... Aug *65
Turbine Runners, Cleaning Large Hydraulic ..... Nov *67
Turbine, Vertical ..... May *44
Turbines, Oil Systems for Industrial Steam ..... Apr *58
..... May *60
Turbines, These Tests Help You Get the Right Oil for Industrial Steam ..... June *77
Twin Branch—A Study of Progress in Power Generation..... Nov *54
Twin 100,000-kw Turbine Generator Sets in Operation at P. G. & E. ..... June *64
Typical Designs of Timber Structures ..... Oct BR 132


# U


Unbalance Can A Generator Stand? How Much Phase ..... June q 75
..... Aug 79
..... Sept. *79
Underground Installations..... July EP 8
Unions, Tube ..... Apr *46
Unit No. 5 on the Line at Harbor Steam Plant ..... Oct *102
Universe and Dr. Einstein, The ..... Aug BR 132
Unusual Pumping Problems in Design and Operation of Granby, New and ..... July *86
Unusual Waste Fuels, Characteristics of ..... June 59
Up an' Atom ..... Feb 80
Uranium Supply, Don't Worry About the ..... Jan *78
Use of Chloride Salts for Freeze-proofing of Coal for Utility Boilers ..... May 57
Use of Exhaust Steam Saves 800 Tons of Coal Annually..... July *79


# V


Vacuum? What Makes Turbine No. 2 Drop Load and Lose ..... Aug q 78
..... Oct 82
..... Dec 82
Value of Pi ..... Feb EP 7
Valve, Atomizing ..... Dec 48
Valve, Ball ..... May *50
Valve Blow? Why Design B. F. Pumps for Safety ..... PE Jan 91
Valve Controller ..... Oct *48
Valve, 50-lb Iron..... May *48
Valve, Freon Relief ..... Nov *46
Valve, 150-lb Dual..... Aug *50
Valve, Lubricated Plug ..... Aug *46
Valve, Operating ..... June *48
Valve, Operating Plug ..... Sept 44
Valve, Pressure Reducing ..... Feb *46
Valve, Reducing ..... June *50
Valve, Relief ..... Aug *50
Valve, Rotary ..... Mar *62
Valve, Rubber Lined ..... Dec *46
Valve, Rubber Pinch ..... Dec *42
Valve, Safety ..... Mar *62
Valve to Blow Incorrectly? Why Did Nipple Cause Safety ..... PE Jan q 90
..... PE Mar 100
..... PE May 83
Valves and They'll Take Care of You, Take Care of Your Safety.. July *90
Valves, Cast Steel ..... Apr *46
Valves, Diaphragm ..... Apr *44
Valves, Instrument ..... Dec *42
Valves, 125-lb SP..... June 46
Valves, Pinch ..... Sept *50
Valves, Solenoid ..... Dec *46
Valves, Steam Jacketed..... June *50
Vaporization Cooling of Large Electrical Machines ..... May *67
..... Sept *82
Ventilation at O. H. Hutchings Station ..... Dec *76
Versenate Test for Total Water Hardness Eliminates False End Points, New ..... Dec *79
Vertical Speed Reducer..... June 44
Vertical Turbine ..... May *44
Vibrating Screens ..... May 50
Vibration Dampeners ..... June *44
Vibration Mounts ..... Nov *46
Vibrators, Shake-out ..... Apr *42
Vibratory Conveyors, Long..... Feb *46
Vise, Column ..... Sept *44
Voltage Be Varied Without Damage? How Much Can Applied Motor ..... PE Apr q 46
..... June 75
Voltage Motor Control, High..... Aug *58
Voltmeter ..... Apr 48
Voltmeter, Expanded Scale..... Feb *42
Voltmeter, Indicating ..... Apr 46
Volumes of Oil and Other Petroleum Products, Calculator for ..... PE May *77


# W


Wage Rates ..... Apr 53
Wages ..... June 53
Walls, Suspended ..... Oct *44
War-Postponed Sewage Treatment ..... Apr EP 8
Warehouse in Dallas, Refrigeration and Power for Alford's New 17-Acre ..... Sept *90
Warning, Steam Load..... PE Apr *85
Wash-Water By Using Wasted Condensate, Increasing Power Plant ..... Aug *60
Washington No. 3 Goes on the Line, Port ..... Mar *66
Waste Fuels, Characteristics of Unusual ..... June 59
Waste Fuels? What Does It Cost You to Burn..... Nov 90
Waste in the Use of Low-Pressure Steam for Heating, Reducing ..... PE Jan *85
Water Cooler, Drinking..... Sept *42
Water Cut-Off, Low..... Nov *42
Water Flow, Pressure Drop, Pipe Size; These Tables Speed Up Pipe Sizing—Steam and ..... July *54
Water Hammer Check..... May *44
Water Hardened at Oakdale Plant of Newport Industries, Soft..... Jan *81
Water Hardness Eliminates False End Point, New Versenate Test for Total ..... Dec *79
Water Level ..... July 53
Water Level, Doubtful..... PE May 80
Water Pollution ..... May EP 7
Water Shortage ..... May 53
Water Systems? That Treatments Prevent Scale and Corrosion in Drinking ..... July q 76
..... Sept 80
..... Oct 80
Water Tube Boilers..... May *46
Water Treatment Courses..... Oct 101
Waterside Completes Its Topping Program ..... May *62
..... Sept *54
Waterwalls, Insulation of Modern ..... Oct *72
Waterwalls, Refractory Enclosures Behind ..... Dec *86
Watts Bar Steam Plant, The..... Oct BR 112
Weatherproof Switch ..... Oct 50
Weights and Measures, "Celsius" ..... Nov EP 8
Welder, Heavy Duty Arc..... Sept *48
Welders, D-C ..... Dec 46
Welding boiler tubes..... Nov EP 7
Wells, George W. ..... Feb 98
Westinghouse to Develop Nuclear Reactor for Ship Propulsion..... Feb 81
Wet, Why the Compressed Air Was ..... Nov *92
What Do You Mean by Thermal Efficiency? ..... PE Jan 87
What Determines Maximum Boiler Feed Pump Discharge Pressure? ..... July *80
What is Best Length for Adjustable Piston Valves on Uniflow Engine? ..... PE Jan q 90
What Rotating Regulators Can Do For You..... June *81
What's New in the Electrical Art? ..... Mar *82
Where Would You Put 300 Tons of Fly Ash Every Day?..... Dec *85
White, Dr. William Monroe..... Apr 96
Who Knows about Incentive Bonus Systems for Ammonia Refrigeration Plant? ..... PE Jan 91
Why Design B. F. Pumps for Safety Valve Blow? ..... PE Jan 91
Why Did Nipple Cause Safety Valve to Blow Incorrectly?.... PE Jan q 90
..... PE Mar 100
..... PE May 83
Why Don't We Have More of It? Central Heating Pays— ..... Dec *88
Why substances "jell"..... Nov EP 8
Will a Rectifier Solve This Problem? ..... PE Feb *92
Winding Diagram, A New Armature ..... Oct *66
Wiring Test Set..... Jan 50
Wood-Metal Packing for Boiler Feed Pumps ..... PE May *74
Wood Refuse, A Stoker for..... Apr *72
Work Bench, Steel..... July 50
World's Largest Turbine Factory, The ..... Apr *77
World's Most Powerful Motor Drive ..... Feb *69
Wrench, Impact ..... May 46
Wrenches, End ..... Sept *42
Wrenches, Pipe ..... Dec *44

## INDEX TO AUTHORS


### B

Bailey, E. G. ..... Feb 53
Bassett, Curtiss D. ..... Aug 74
Bean, C. H. ..... June 54
Beckman, Arnold O. ..... Oct 77
Bixler, D. F. ..... Apr 81
Bourbonnais II, Telesphore L. ..... Nov 76
Bouton, Herbert ..... July 84
Burns, R. E. ..... Sept 70
Buss, J. R. ..... Feb 73
Butcher, Ira A. ..... June 88

### C

Carroll, H. C. ..... Mar 102
Cassie, Jack ..... Oct 62
Christie, A. B. ..... Sept 64
Cooper, Edgar A. ..... Nov 84
Cunningham, T. F. ..... Jan 87
Custer, C. C. ..... July 90

### D

Darling, George ..... Oct 84
Darnell, J. R. ..... July 58
..... Nov 90
Davidson, Ward ..... Nov 75
Davis, Wm. N. ..... Nov 77
Dole, C. Russell ..... Dec 76
Duell, N. W. ..... Mar 98

### E

Earle, Chester R. ..... Mar 78
..... June 61
Eisenschiml, Dr. Otto ..... Mar 65
Engelman, William H. ..... Feb 82
..... Mar 94
..... Apr 82
..... May 78
..... June 59
..... July 60
..... Aug 72
..... Sept 74
..... Oct 86
..... Nov 82
..... Dec 74

### F

Fiala, S. N. ..... Nov 54
Fisher, M. H. ..... Apr 66
..... June 81
Forbes, B. G. ..... Sept 60
Fortney, W. H. ..... Aug 81

### G

Gayek, H. W. ..... Mar 73
Gaylord, William W. ..... Aug 92
Gibbons, James O. ..... July 79
Gibbs, C. D. ..... Sept 94
Gillespie, R. D. ..... Feb 54
Green, Charles H. ..... Dec 58
Gusler, Denard L. ..... Apr 72

### H

Hasskarl, P. L. G. ..... Apr 54
Hicks, Tyler G. ..... June 66
..... Dec 63
Holman, George ..... Apr 62
Hope, Clarence W. ..... Apr 53
Housel, Leslie H. ..... Aug 60
Hudson, Wilbur G. ..... Feb 70

### J

Justice, William C. ..... May 58

### K

Kammer, H. A. ..... Nov 54
Karassik, I. J. ..... Nov 72
Kaufmann, R. H. ..... Feb 64
Kilsby, E. R. ..... Jan 69
..... Feb 59
Knecht, H. ..... Sept 54
Kramer, Andrew W. ..... Jan 78
..... Feb 78
..... Mar 82
..... Mar 86
..... Apr 74
..... May 72

### L

LaCoste, Richard ..... Aug 88
Lane, F. A. ..... Nov 54
Lindgren, Gilbert ..... Apr 53
..... Apr 85
Linn, Frank C. ..... Apr 58
..... May 60
..... June 77
..... Aug 63
Los, H. Wieland ..... Jan 82

### M

McCrumb, F. R. ..... Dec 79
McDermid, H. B. ..... Jan 85
..... Nov 67
McGarvey, Francis X ..... May 86
..... June 60
McIntire, L. Boyd ..... Oct 96
Manier, J. Richard ..... July 56
Martinez, Jr., Sergio ..... May 76
..... July 96
Meyers, A. J. ..... July 82
Molloy, Everett W. ..... Oct 77
Morgan, W. E. ..... May 84
Moses, Eliot B. ..... July 80
Mosher, Fred D. ..... Nov 64
Moulton, Albert H. ..... Apr 85
..... Nov 92

### N

Nichols, B. R. ..... Oct 59

### O

Olson, O. E. ..... Nov 102
Ordinanz, William O. ..... June 59
Ormes, Robert M. ..... Aug 62
Oscarson, G. L. ..... Dec 68

### P

Parks, Charles W. ..... Apr 84
Persinger, Marvin M. ..... July 80
Porter, Lyle B. ..... Oct 75

### Q

Quintero, Eusebio ..... Feb 84

### R

Raven, John ..... Apr 82
..... May 75
..... July 78
..... Aug 96
..... Oct 94
Reid, D. G. ..... Feb 62
Reintjes, George P. ..... Dec 86
Reiter, Fred M. ..... May 57
Reynolds, John G. ..... Jan 86
..... Feb 86
..... Feb 88
Rice, William T. ..... May 70
Rich, E. A. ..... Dec 64
Richards, A. E. ..... Dec 88
Rios, G. Amador de los ..... Sept 65
Roberts, R. T. ..... May 62
Rudulph, E. A. ..... Mar 70
Ryan, W. H. ..... Aug 54

### S

Schubert, Fred E. ..... Aug 57
..... Nov *94
Schweisheimer, Dr. W. ..... Mar 92
..... Dec 96
Stevens, W. D. ..... Oct 72
Stickney, A. B. ..... July 54

### T

Taylor, William T. ..... Oct 66
Thomas, William L. ..... May 74
Thompson, Joseph ..... May 86
..... June 60
Thompson, R. C. ..... Aug 58
Trail, Thomas ..... Mar 90
..... Mar 96
..... Aug 94
..... Dec 98
Turnbull, E. J. ..... Aug 54
Turner, W. H. ..... Nov 60

### V

Vance, Harry W. ..... Oct 54

### W

Wakefield, John E. ..... Apr 78
..... Dec 92
Walsh, E. F. ..... July 74
Warner, W. E. ..... Sept 88
Welsh, J. W. ..... Mar 76
..... Apr 69
Westin, L. J. ..... Feb 74
Wood, John ..... Sept 70

### Y

Yavitch, Y. ..... Apr 53